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ABSTRACT

This training module is part of a series that provides a basic introduction to using assistive technology with young children (ages 2 to 7) who have severe disabilities in more than one area of development. This module focuses on using appropriate technologies for positioning children comfortably so they can participate in the activities of life, and provides ideas about helping children activate technology and move about even when their arms and legs are inefficient or do not allow them to crawl or walk. A suggested format for assessing and providing technology that will help a child access technical devices is provided, along with a discussion about using technology for environmental control. An introduction outlines the role of technology, myths and realities about technology, members of the technology team, and service delivery models. Other chapters focus on: (1) technology for positioning (importance of proper positioning, guiding principles, and positioning technology); (2) technology for access (considerations for selecting access technology, selecting the control site, mounting the device, selecting the access device, and selecting and implementing access technology); and (3) technology for mobility (mobility devices, control devices, selecting or building the device, potential roadblocks to using the device, and training for mobility). Appendixes provide an assistive technology resource list, resources for positioning and mobility, resources for access, a case study, resources for funding options, and characteristics of selected wheelchairs. A videotape, entitled "Assistive Technology: We Can Do It!," was developed to accompany this module and related modules. (Contains 11 references.) (JDD)

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Technology in the Classroom

Applications and Strategies for the Education of Children with Severe Disabilities

Positioning, Access, and Mobility Module

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AMERICAN SPEECH-LANGUAGE-HEARING ASSOCIATION

Positioning, Access, and Mobility Module

Technology in the Classroom

Applications and Strategies for the Education of Children with Severe Disabilities

by

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edited by

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September 1992

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Dedicated to the families, teachers, and service providers who are untiring in their efforts to help young children with severe disabilities reach their full potential.

The purpose of this module is to give you information about assistive technology that will be helpful to you and your child or the children you serve. Therefore, make it work for you. Read only what you want to know now; read the rest later when it is pertinent to your needs.

Preface

With the advent of assistive technology, a new world opened up for children with severe disabilities. They now would be able to move about, communicate, and learn, often alongside their able-bodied peers. However, making this technology available to these children and teaching them how to use it was not, and is not, an easy task. How do you go about informing educators and related service providers about the intricacies, challenges, and benefits associated with using technology? How do you help them to become comfortable using assistive devices as tools that can enhance, rather than interfere with, their daily teaching and other responsibilities?

Technology in the Classroom: Applications and Strategies for the Education of Children with Severe Disabilities, a 3-year project funded in part by the U.S. Department of Education, tries to address these questions. The American Speech-Language-Hearing Association (ASHA) designed this project to develop, field-test, and evaluate the effectiveness of self-instructional materials that would improve the knowledge and skills of families, teachers, and related service personnel so that they could use assistive technology effectively in the educational programs of young children with severe disabilities. Development of these materials involved the collaborative effort of many individuals who contributed significantly to the final products.

Authors. These materials were authored by clinicians and teachers who have many years of experience in the field of assistive technology. Sarah W. Blackstone, E. Lucinda Cassatt-James, Elaine Trefler, and Carol Flexer all have seen young children struggle to walk, talk, learn, and listen before most of the assistive technologies available today existed. They know today's technology because their input helped to develop it. It was their vision and creativity that guided the direction of this project. Their respect for children, their skills in determining children's needs, and the depth of their knowledge regarding strategies to use in meeting those needs have been demonstrated in the content of the project materials, along with their ability to share this knowledge in a clear and understandable manner. We all are indebted to these women for their long-term dedication to, and advocacy for, children with disabilities.

Site Coordinators. Two field tests were conducted during the course of the project to help us determine whether the project materials were actually useful in providing families, teachers, and related service providers with strategies for incorporating assistive technologies into the educational programs of young children. A local field test was conducted in Montgomery County, Maryland; we are grateful to Tom O'Toole, Sandra Lebowitz, and Nancy Gould for helping us to conduct this field test and for facilitating a smooth working relationship with public school personnel. The second field test, which was conducted at the national level, was made possible by the willingness and gracious efforts of Peggy Locke in Minnesota, Richard Lytton in Rhode Island, Judy Montgomery in California, and Gail Van Tatenhove in Florida. Not only did they locate the field-test sites and

participants, but with their knowledgeable input they facilitated the fine-tuning of field-test evaluation instruments to better suit potential field-test participants. They also provided valuable input into the structuring of project materials. Their enthusiasm for the project, their care in completing tedious tasks, and their collective sense of humor all contributed enormously to the successful completion of the project.

External Advisors and Peer Reviewers. So many individuals gave freely of their time and energy to review the project materials, each contributing to the preparation of a better product. With heartfelt thanks we acknowledge Mary Brady, Linda Burkhart, Philippa Campbell, Cynthia Compton, Susan Elting, Don Goldberg, David Hawkins, Susan Hough, Mary Blake Huer, Bill Lee, Janice Light, Bill Lynn, Noel Matkin, Shirley McNaughton, Beth Mineo, Marion Panyan, Kathy Post, Susan Quinlisk-Gill, Eileen Raab, Mark Ross, Janis Speck, and Lana Warren.

Internal Advisors. This group (Stan Dublinske, Kathryn Nickell, Cassandra Peters-Johnson, Diane Paul-Brown, Helen Pollack, and Jo Williams) supported the project throughout all of its phases and provided insightful suggestions, for which we are extremely grateful.

Project Staff and Significant Others. Special thanks to Mary Anzelmo for getting the project started, and to Ellen Fagan, ASHA's director of continuing education, for helping us to develop the project's field-test tools that were so effective in demonstrating changes in field-test participants' attitudes. Eilen also was an appreciated counsel with regard to field-test procedures and data analysis. Tarja Carter, director of ASHA's graphic services, and her staff were a source of never-ending talent when it came to preparing text, brochures, posters, module covers, and all project artwork. Joanne Jessen, ASHA's director of publications, and her staff of editors who reviewed the project documents provided advice regarding publication issues and editorial questions. Personal thanks go to Charles Diggs (ASHA's director of consumer affairs) for his counsel in preparing the project videotape, and to Amie Amiot for her untiring efforts in formulating statements about public laws. If it had not been for James Gelatt and Camille Catlett, who were responsible for the original grant preparation, this project never would have begun. Acknowledgment also goes to our project officer, Patricia Hawkins, and the Office of Special Education Programs, U.S. Department of Education, for their continuing support.

Stan Dublinske, director of ASHA's Professional Practices Department, was a constant source of strength with his clear thinking and concise solutions to some of the thornier problems. Cheryl Wohl contributed liberally during the initial phases of the project and carefully saw to the preparation of field-test materials. Many thanks for her continued support.

The project, however, would never have come to completion without the guidance of the project manager, Deborah Bruskin, who held the hand of this project director until she knew the ropes of the National Office and procedures for interfacing with the Department of Education. This moral support continued and made

possible the project's movement through its more difficult times. Her excellent writing skills helped significantly in developing the written materials. Many thanks to a competent colleague and constant friend.

Personally, I have grown markedly from my involvement in the development of this project. Most certainly, it has changed the direction of my professional life, and I sincerely thank all those with whom I have had the pleasure of working for these past months.

We hope that the results of our efforts, including three modules, one supplement, and one videotape, will find their way into the hands of families and professionals eager to meet the technology needs of young children with severe disabilities. We present them to you with some measure of assurance that they will be helpful and that, hopefully, children's potentials will be better realized. In a world of such rapid technological changes, I challenge you to get started now! It may be your own insight and experience that contribute to a second publication of this sort.

Nancy T. Harlan
Project Director

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Chapter I Introduction

Welcome to the world of assistive technology! If you are reading this module, you are undoubtedly curious about what assistive technology means and the role of this technology in the education and lives of young children with severe disabilities. As defined by the Education of the Handicapped Act Amendments of 1990: "The term 'assistive technology device' means any item, piece of equipment, or product system, whether acquired commercially off the shelf, modified, or customized, that is used to increase, maintain, or improve functional capabilities of individuals with disabilities." [Sec. 101(g)]. Many of you may be from the "paper and pencil generation" or may have used technology in a business context only. Whether you a·e a family member, a teacher, or a related service provider, you consider yourself a novice in the use of technology for young children with severe disabilities.

To ease your entry into this new and exciting area, we have prepared a series of modules that provide a basic introduction to using assistive technology with young children (ages 2–7) who have severe disabilities in more than one area of development (i.e., motor, communication, and/or cognitive). However, the content of these materials may be extremely helpful to families, teachers, and related service providers of children who have a severe or even mild disability in only one area of development. The *Communication Module* delves into technology that gives children another way to communicate when speaking is difficult or impossible. The *Positioning, Access, and Mobility Module* gives readers ideas about how to position children comfortably so they can participate in the activities of life, as well as ideas about helping children activate technology and move about even when their arms and legs are inefficient or do not allow them to crawl or walk. The *Education Module* has descriptions of technologies that help children do pre-academic as well as academic tasks—tasks that help them learn how to learn. It also addresses computer terminology and adaptations to computers that make them usable by children with disabilities. A supplement entitled *Listening and Hearing* contains suggestions about hearing technologies and listening strategies that improve a child's opportunities to learn from his or her environments. The accompanying videotape, entitled *Assistive Technology: We Can Do It!*, provides an overview of the technologies and strategies discussed in the written materials and shows children using them successfully in learning environments.

Parents and professionals who reviewed the modules (as part of a national field test) agree the videotape is most helpful when viewed before reading a module. This national field test of project materials also revealed two statistically significant findings: (a) 62 family members as a group and 99 professionals as a group became more comfortable with their knowledge of assistive technology, and (b) the professionals as a group began to feel more competent in using assistive technology. Preliminary findings of a local field test (conducted before the national test) indicated findings similar to (a) above. Follow-up of local field test participants one year later indicated an increase in participants' (a) level of awareness of assistive technology, and (b) efforts to seek additional information and resources about assistive technology. Thus, we present these materials to you with some degree of confidence that they will be helpful.

Role of Technology

Technology has become an integral part of the lives of all children today. Two-year-olds are operating the remote control for the television, turning on lights, and pushing the button on the automatic garage door opener. Three-, four-, and five-year-olds, as well as first and second graders, are operating microcomputer-based toys, such as "Speak and Spell," and are playing computer games at home using their parents' or older siblings' computer.

Assistive technology enables children with severe disabilities to participate more fully in all aspects of life (home, school, and community) and helps them access their right to a free, appropriate, public education in least restrictive environments. Part B of IDEA* states that a child's needs for assistive technology services and devices must be considered by the team formulating his or her Individualized Education Program (IEP) or Individualized Family Service Plan (IFSP). If the team determines that the child needs assistive technology to receive a free, appropriate, public education in the least restrictive environment, the child's IEP/IFSP must include a specific statement of such devices and services, and these devices and services must be provided. This is a landmark decision that allows students with severe disabilities to be fully integrated into the educational system. Although this decision will improve the quality of education for children with disabilities, it also presents a great challenge to the teachers and families, as well as a variety of service providers, who must use the technology to assist these children as they strive to achieve independence in a difficult world.

The perspective of the authors is that assistive technology is an enabling tool that provides access to learning. It is most effective when applied in combination with traditional teaching techniques to achieve the best learning environment for children with disabilities. Alone or in combination with other techniques and strategies, assistive technology is not a panacea for all learning challenges. Experience has shown that a child's ability to operate a piece of equipment has little impact on his or her educational achievement. For example, simply using a switch to turn on a toy does not necessarily mean that an understanding of cause and effect has occurred. This ability is only one of many events in a child's life that may lead to the acquisition of such a basic cognitive skill. Likewise, pointing to symbols on a vocabulary overlay does not spontaneously translate into functional use of those symbols for purposeful communication.

Applied carefully and skillfully, assistive technology can play an important role in meeting the needs of children with severe disabilities. Technology can assist these children in participating in the educational curriculum and in acquiring social skills (now being able to interact with peers and siblings). It can help them master skills needed for independent living. They do not miss out on the fun and excitement of being children.

* This is an amendment to the Education for All Handicapped Children Act of 1975 (P.L.94-142), which was first amended as P.L.99-457.

Myths About Technology

Myth # 1: Technology limits speech and mobility.

Almost anyone who has had to decide whether a child should be given technology has asked the following questions.

"Won't technology keep children from learning to walk or to talk? Won't it make them lazy so they don't try as hard to develop their abilities?"

- We need to think of assistive technology as *a supplement, not a replacement,* for skills that are not yet present. Assistive technology may actually facilitate the development of skills or at least allow for the development of parallel skills. For example, the lack of mobility could delay cognitive development or social independence. However, with the provision of a mobility system, children can explore their world, fulfill family responsibilities such as getting to the kitchen on time for meals, or participate in school routines such as delivering messages to the school office. If walking for short distances becomes possible, the mobility device might just be used for activities such as playing on the playground at recess. The idea of a "wardrobe of devices" can be helpful (i.e., providing the child with a collection or choice of mobility options). This is not unlike children without disabilities who use various methods of mobility, such as bicycles, scooters, skates, and so forth. It is vital to remember that a specific assistive device can always be discarded if and when a child acquires new skills.
- The early application of augmentative communication approaches does not inhibit the development of speech and language and may actually *prevent the establishment of maladaptive communication patterns* (Blackstone, 1990). If, for example, initial attempts at interaction get off to a bad start (either because the children's communication signals are not being sent or not being received), the probability of the children acquiring an awareness that what they do has a specific effect upon others in their world is very low. This set of circumstances is known to lead to "learned helplessness," behavior problems, or passivity, which constitute major barriers and handicap people well beyond their level of impairment later in life (Abramson, Seligman, & Teasdale, 1978). Assistive technology can facilitate children's communication so that their communication attempts are more accurately understood and responded to.

Viewing the success that other children with similar disabilities have had with assistive technology can be very beneficial. Videotapes, films, written materials, support groups, and live observations can all be helpful in seeing the long-term benefits of technology.

Myth # 2: New technology is very difficult to use.

Many of us are skeptical about our own ability to use complex equipment; just the thought of using assistive technology arouses feelings of anxiety and intimidation. However, it is important to remember that:

- To facilitate your child's use of technology, you do not have to be an expert in using computers or other such "high tech" devices. There are experts who are trained to help you understand how the technology works.
- You learn only the functions of the computer/device that your child needs now. When your child needs a new function, you both can learn how to do it.
- Don't be put off by the terminology that is used when discussing computers or technology in general. As you begin to understand how to make the device work for your child, you will learn the related vocabulary.
- Although the first few steps taken toward the implementation of technology may be difficult, competence comes gradually and will eventually provide you with a sense of accomplishment and pride, both for yourself and for your child.

And there are resources that can help. Federal legislation has mandated that all states be funded to develop consumer-responsive, statewide, technology-related service delivery. Those states funded to date and their respective addresses and telephone numbers appear in Appendix A, "Assistive Technology Resource List." Also included in Appendix A are listings of organizations and agencies that provide assistance about applications of assistive technologies, pertinent publications, funding resources, and databases of assistive technology resources (e.g. manufacturers, products, publications, and services).

Realities About Technology

Reality # 1: Assistive technology is still being developed.

Assistive technologies for young children have not yet been developed/refined to the level of the television or the telephone. Because of this, limitations, "bugs," breakdowns, problems, and irritations exist, and we need to be prepared for them.

Reality # 2: Funding for assistive technology is a challenge.

Although funding is and will no doubt continue to be a challenge, this situation has improved in recent years. Funding sources now include federal and state programs, private insurance, and other sources, such as philanthropic groups. The Funding Resources section of Appendix A contains a list of current manuals and references that can help families and professionals sort through this funding maze. Equipment manufacturers also frequently provide information about funding resources.

Reality # 3: Applications of assistive technology take time and effort.

Utilizing assistive technology is time-consuming. For example, many, many symbol displays/overlays must be developed to enable one child to communicate at school. This child also requires displays/overlays for communicating at home and in the community. The child's communication aid also will require programming. In addition, planning and meeting time must be provided if assistive technologies are going to be fully integrated into a child's learning environments.

As this technology becomes more sophisticated, it also is becoming easier to use. For example, communication symbol displays now can be created and then produced on a printer. Some communication aids can be programmed by pressing buttons and speaking into a built-in microphone. Manuals are user-friendly, and manufacturers offer workshops and videotapes to help people understand how to use the equipment that they purchase.

In spite of these advances, it is necessary for administrators to understand that preparation, planning, and meeting time is needed if assistive technologies are going to help children be successful in reaching their full potential.

Reality # 4: Assistive technology should be used with care.

Assistive technologies are wonderful tools, but if they are used without discretion or inappropriately, they can harmful. For example, providing a child with an assistive listening device without input from an audiologist regarding amplification settings can result in permanent hearing loss. A child using an electric wheelchair without instruction from the occupational or physical therapist may be unable to stop the device before it rolls into a busy street or hits other children. Choosing augmentative communication aids without the expertise of a speech-language pathologist who knows the broad range of options and their suitability for children with different language capabilities can result in such frustration that a child's overall desire as well as ability to communicate may be diminished rather than increased. It is very important to seek out knowledgeable guidance from trained professionals so that the right decisions can be made about assistive technology devices and their applications.

Technology Team

It is essential that decisions about a child's use of technology be made by a team of professionals and family members to ensure that the child will benefit from a broad perspective of knowledge and experience. Members of a child's team change over time; only the child and, sometimes, the family remain constant. Thus, although each team member plays an important role along the way, the job of a team is to empower the child and the family to make decisions, to take control of the process, and to seek out new resources when they need them.

Research and practice suggest that teams function best when roles and responsibilities are clearly delineated. The members who usually make up a child's team are described below*:

- **Child** – Children are the only constant on the team, bringing with them their unique personalities, abilities, challenges, and fantasies. The children are active participants, and their opinions must be respected and valued. After all, they are the ones who will or will not benefit from technology, and will or will not use it.

- **Family** – The family provides support and helps to develop the child's world knowledge base. It is important to realize that many families have concerns unrelated to their children with disabilities that will affect their level of participation. In some cases, cultural issues and existing family dynamics may even inhibit active involvement. Varying degrees of participation are understandable and acceptable. The family can be a child's best advocate and can develop a child's sense of confidence, self-esteem, and independence.
- **Aides/instructional assistants** – These individuals work with teachers to implement the curriculum and make learning possible. They play a key role in fostering peer interaction, self-confidence, and independence.
- **Audiologists** – Audiologists test hearing, recommend hearing technologies, and provide instruction in the use of hearing technologies. They also give suggestions for enhancing children's listening skills.
- **Classroom teachers** – The classroom teacher is responsible for the child's total education program. Teachers must balance the activities and time available during the school day and collaborate with the family and other professionals to ensure that the "educational path" is followed. They develop and implement educational strategies that allow assistive technology users to participate in classroom activities so that functional, academic, and social goals can be accomplished.
- **Occupational therapists** – Occupational therapists, like physical therapists, evaluate children's posture and mobility. Occupational therapists then recommend and implement procedures and devices that will meet seating and mobility needs. In addition, occupational therapists help determine which devices and strategies children can use to access other technologies, such as those for learning and communicating, as well as moving.
- **Peers** – Children's peers may be friends, classmates, helpers, and tutors. Peers provide emotional support and a special link to certain aspects of children's lives in which adults have little involvement. They provide models for learning and communicating.
- **Physical therapists** – Physical therapists evaluate children's posture and mobility and are subsequently involved in recommending and implementing a variety of techniques, devices, and strategies that will appropriately position the children to facilitate their comfort, proper development, and safety, and that will increase their mobility.
- **Physicians** – Physicians address medical issues and monitor medical complications. They are involved in the prescription of the seating and, often, the mobility device. The physician helps to procure funding from third-party payers (e.g., insurance companies).
- **Psychologists** – Psychologists assess children's intellectual abilities and learning styles. They must be skilled at making necessary adaptations to determine a child's cognitive functioning, taking into account present physical disabilities and behavioral characteristics.

* Except for the child and the family, potential team members have been listed in alphabetical order.

- **School principals, directors of special education, superintendents** – These designated leaders have job descriptions that involve management of educational programs and fiscal issues. They are leaders and set the tone. They understand the school system and often can make things happen. They have the authority to allocate staff time as deemed appropriate. Their support is often critical to the successful implementation of assistive technology.
- **Special educators** – Teachers with special education backgrounds develop an in-depth understanding of each child's cognitive profile and learning style as they relate to the curriculum. Based on this knowledge, the special educator can modify curriculum goals and materials and provide additional resource support, such as recommending software that enables children to participate in classroom activities (e.g., art projects, creative writing).
- **Speech-language pathologists** – Speech-language pathologists suggest ways to maximize a child's speech, language, and communication during each activity (e.g., use of a communication device during circle time and a mini-board at home during bathtime). They often help develop vocabularies, design overlays, suggest strategies to facilitate interaction, and integrate speech and language development into the educational curriculum.
- **Team facilitator** – This individual possesses the knowledge and the skills to coordinate team meetings, ensure follow-through of team goals, see that time lines are met, and generally manage team activities so that no activity deemed important "falls through the cracks."
- **Technical resource personnel** – Rehabilitation engineers and/or technologists and assistive equipment suppliers/manufacturers help make decisions when specific technology is being considered. They can assist in procuring, designing, fitting, and maintaining the equipment and can also help in setting up/modifying equipment and software and designing work stations.

The individuals cited above play an important part in helping children use technology effectively. The roles they play often vary; those who implement the use of technology are not always the same as those who prescribe or design it. The level of expertise among these people in using technology also varies. Each person contributes his or her own unique skills, talents and personality; together they make assistive technology work. And, it is important that teams provide continuity and plan for smooth transitions as the child grows and moves through the educational system.

Service Delivery Models

Service delivery to children with severe disabilities can generally be categorized according to different "models," three of which are described below. Within each model, note how the focus of attention and the responsibilities change. Professionals and families vary as to the model with which they feel most comfortable. As families' needs change or as they learn more about dealing with their children's technology needs, they may change their model of choice. In some settings a certain model may be required, but within each circumstance there should be flexibility to meet the needs of both the children and their families.

- **Family-centered model:** This model is designed to
  - empower and enable the family as a system,
  - promote independence, not dependence, and
  - support and strengthen the family's competence in negotiating its own course of development.

  In the United States, the family-centered approach is an integral part of service delivery in infant and toddler programs with funding under the Individuals with Disabilities Education Act (IDEA).
- **Medical model:** This model is child-centered (i.e., the professional focuses on bringing about changes in the child). Families are often not expected to take an active role.
- **Educational model:** The educational model reflects the regulations inherent in P.L. 94-142. Intervention is child-centered, and success often is measured by whether discipline-specific goals are met. Families are expected to be part of the decision-making and training process; the training of family members and the development of home programs are inherent to this model.

No matter which model is used, unless there is collaboration among the team members, the implementation of assistive technology is doomed.

> In the collaborative model, it is assumed that no one person or profession has an adequate knowledge base or sufficient expertise to execute all the functions (assessment, planning, and intervention) associated with providing educational services for students.... All team members are involved in planning and monitoring educational goals and procedures, although each team member's responsibility for the implementation of procedures may vary. Team members can be considered as sharing joint ownership and responsibility for intervention objectives. (ASHA, 1991)

Mobility Module

Now that you have a brief background in assistive technology, you are ready to delve a little deeper into the specific ways it can be used to help young children with severe disabilities. This module introduces the reader to the importance of proper positioning as well as considerations in selecting and using appropriate technologies for positioning. A suggested format for assessing and providing technology that will help a child access technical devices is provided, along with a discussion about using technology for environmental control. Basic principles for a child's mobility needs and the use of assistive technology to meet those needs are presented.

So read on, and be assured that with appropriate technology and support, all children, even those with severe disabilities, can grow up to be happy, participating members of their communities and society.

Chapter II Making a Move Toward Technology

Technology enables children with physical disabilities to compensate for motor skills that are delayed, abnormal, or absent. Children who cannot sit or move independently as a result of their physical disability are the children who will need seating and mobility systems to reach their full potential.

Assistive technology for mobility/positioning can facilitate, on a temporary or permanent basis, a child's participation in age-appropriate activities, thereby

- encouraging normal development of mobility through play skills and social interaction;
- maximizing functioning in all areas of motor, social, linguistic, and cognitive growth; and
- preventing, delaying, or accommodating orthopedic deformity.

Movement is a critical component of normal child development. If independent mobility is not possible, technology is available to supplement or compensate for motor skills that are not present.

There are three basic steps that need to be taken to provide mobility for children with severe disabilities:

- **Step One** – Position child in a stable but functional posture to reach and operate devices.
- **Step Two** – Provide child with a functional system to access technology. This system may include one or more switches. Decisions about which motor skills are needed to operate the technology (e.g., switch) must be evaluated thoroughly.
- **Step Three** – Determine child's functional needs for independent mobility and match these with the appropriate mobility technology.

After the appropriate technologies have been chosen, training in their use and incorporation into the child's life-style can begin.

As stated in the introduction, the major areas that will be addressed in this module are positioning, access, and mobility.

Chapter III Technology for Positioning

Positioning is defined as the act of placing a child with disabilities in a posture of readiness to perform. The goal of proper positioning is to place children comfortably in positions from which they can participate in the activities of life, that is, positions from which they can

- pay attention,
- move their heads to see and hear ongoing events,
- shift their weight in their chairs or change positions,
- breathe with ease,
- place their hands where they wish, and
- manipulate objects to activate switches that operate technical devices.

Positioning encompasses lying, standing, and other body positions in addition to sitting; all are necessary to ensure comfort and function. Positions should be varied (e.g., at floor level, at desk height, on wheels) and for specific functions (e.g., bathing, using the toilet, eating, transporting by car, or sleeping). Proper positioning technologies should

- be employed at an early age;
- grow or change with the child;
- be aesthetically appealing to young children, their peers and their families; and
- be easy to use.

Importance of Proper Positioning

Proper positioning of children with severe disabilities is essential for

- **functionality** – A stable central body posture (e.g., the proper positioning of the trunk) promotes maximum use of the body. This enables a child to be both physically and psychologically ready to perform activities.
- **access** – It enables a child to utilize other assistive technology efficiently.
- **esteem** – It promotes a positive self-image.

Guiding Principles

Following are basic principles to keep in mind for positioning:

- Technology for positioning is considered the cornerstone of all other technology-related activities.
- Most children with motor problems have positioning needs; however, device priorities will vary for each child. For example, for the child with a developing scoliosis (a lateral curvature of the spine), the first priority is to design a posi-

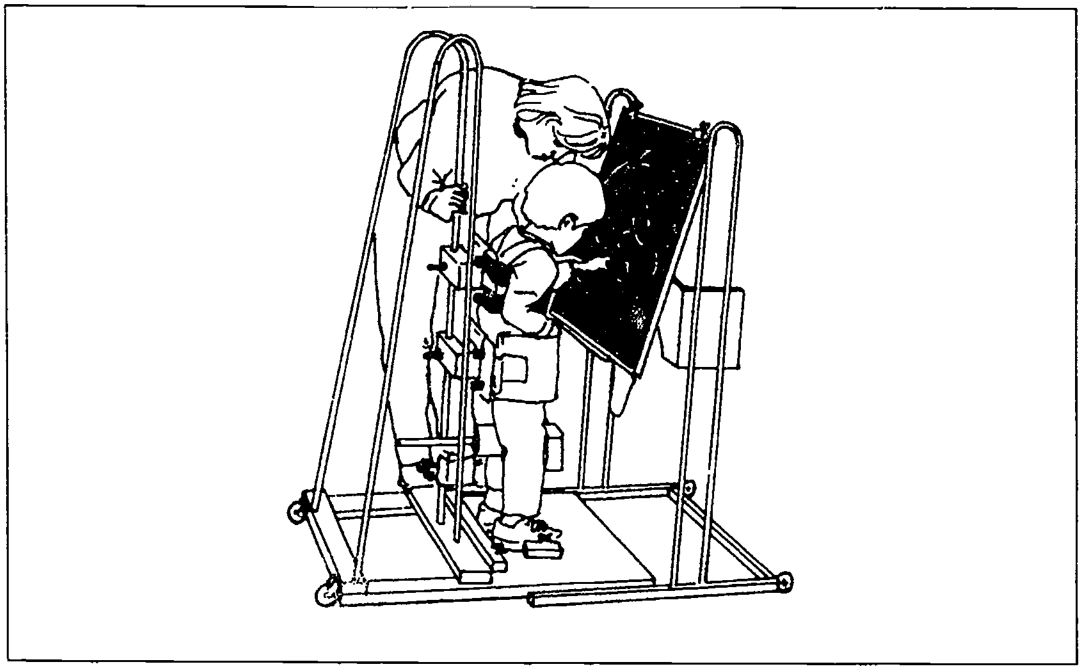
tioning system that will control the scoliosis, thus preventing future medical complications. Then attention can be directed toward maximizing the child's ability to participate in daily activities. For other children, providing comfort may be the first priority. For the child who has the potential to benefit from standard classroom equipment but whose motor skills are problematic, positioning must maximize those motor skills needed to access a computer, a powered wheelchair that carries a communication device, and perhaps other school-based equipment. Priorities must be set for positioning goals for each child. *Remember, when compromises are made, the concerns of the child, the family, and the school must be considered.*

- There are no prerequisites to positioning. In all cases, attention should be given to the child's posture. Muscle tightness, abnormal postures, and/or restricted movement will eventually lead to bone deformities, discomfort, and reduced functional abilities. Proper positioning does not just help the child achieve functionality; it is an absolute necessity for the child's physical well-being. If motor problems are evident, positioning begins in the newborn nursery and continues, with constant reassessment for growth as well as functional and environmental changes, throughout life.

Positioning Technology

Positioning technology can be used to place a child in many functional positions. Examples include:

- **standing frames (prone, supine, or upright)** – Standers place children in upright positions so they can participate in age-appropriate activities (e.g., writing on the chalkboard, washing dishes either in play or at home, presenting during show and tell, playing at the sand table, etc.) (see Figure 1). In addition, some believe that standers promote good body physiology, thereby enhancing the development of strong bones, efficient operation of the respiratory and digestive systems, and so forth. Standing frames allow children to change their positions and to see the world from a new perspective.
- **walkers** – Walkers aid in coordination, promote safety to prevent falls, and provide upright support.
- **crawling assists** – Crawlers support a young child's body weight so the child can use his or her arms and legs to move about on the floor.
- **sitting equipment** – Sitting equipment provides pelvic and/or trunk stability, thus enabling children to use their hands for play or work. Such technology could involve something as simple as cutting the legs off a small classroom chair so the child's feet touch the ground while sitting at a school desk. Or, it might mean a small, adapted commode chair that would allow the child to sit independently while using a toilet.
- **floor positioners in prone, sidelying, and supine positions** – Floor positioners may help prevent deformities of muscles and bones and promote normal patterns of movement.



Drawings by Melissa Turner

Figure 1 – Child using a standing frame for functional activities

The age of the child and the type of school program will determine not only the seating and mobility system requirements, but the need for alternate positioning equipment as well. Teachers should ask the physical and/or occupational therapist about a variety of choices for positioning young children so that they can best participate in classroom activities. For example, a sidelyer would be appropriate for nap time or for circle time. A prone stander may be used to provide stability, thus enabling a child to watch an educational television program or use a computer. No one can remain comfortable in the same position for hours at a time. Children will fatigue even in a well-designed system. We must be able to detect the deterioration of posture and offer alternate positions. For example, children with low tone in their trunks cannot tolerate an upright posture for extended periods. This position hould be used when the teacher requires upright posture for attention or access to other technology, such as computers. Other, less demanding positions (e.g., positions that utilize sidelyers) should be used as needed to give the child time to rest and recover from muscle fatigue.

With the assistance of a physical or occupational therapist, some equipment can be purchased commercially through a catalog or from a rehabilitation technology supplier. For some children, the commercially available equipment must be modified or custom equipment fabricated to meet their needs. Of course, the cost of the equipment is proportionally higher as the need for customization increases.

The degree of the child's motor disability will determine which type of equipment is obtained. It is these decisions that are made by the technology team that is described in the Introduction; physical and occupational therapists play a significant role here.

Selecting a Seating System

It is critical that children be sitting as well as possible before considering their potential for access to other technologies, such as mobility devices. Because the child usually controls other technology (e.g., adapted toys, communication devices, computers) from the wheelchair, selection of the seating system for the wheelchair is most important.

The process of assessing a child for a seating system must include all people who interact with the child on a daily basis (i.e., family members, peers, teachers, teacher assistants, therapists, etc.) because these people know the level of function expected of the child. Physical and occupational therapists, rehabilitation technology suppliers, and rehabilitation engineers can be especially helpful in translating the child's functional ability and positioning needs into technological solutions. Following their evaluation, the seating team will make recommendations to the family regarding the type of system, the support contours, and the components appropriate for a given child.

The assessment results will indicate the technology that will best meet the child's needs. As there are so many choices of seating systems and wheelchairs, and because prices can range from hundreds to thousands of dollars for each component, the technology selection must be made carefully. Mistakes are costly, and children may be forced to use inappropriate technology for years until new financing is found.

In selecting the seating system, the team will look at the physical, psychosocial, economic, growth, and height considerations that will affect the child.

Physical Considerations:

Children with physical disabilities have somewhat predictable physical conditions.

- Those with spinal cord injuries have no or partial sensation or muscle activity below the level of their injury. If the spinal cord is damaged just above the waist, then the legs and lower trunk are paralyzed and there is no feeling or voluntary movement below the site of the damage. If the injury is to the neck, the arms and trunk also experience motor and sensory loss. Therefore, the seating system should be selected for its ability to relieve pressure, thus preventing skin breakdowns from occurring, and for its ability to provide sufficient support to ensure a stable midline posture.
- Children with spina bifida, a congenital lesion of the spinal cord, have no sensation or muscle ability below the level of their spinal deformity; often, they have very thin skin over the areas on the back where surgery has been performed to repair the birth defect. Again, the seating system must prevent skin breakdown. Being seated on a good quality cushion or foam helps prevent injury under the buttocks; custom contouring is often needed to accommodate the abnormal curvature of the spine. Alternate floor-level mobility, such as caster carts or hand-propelled mobility devices, help prevent injury to the legs

and heels that occur as the children pull themselves around on the floor. Children with spina bifida or spinal cord injuries are also incontinent, so seating materials must be soil-resistant until a routine is established to manage bowel and bladder care.

- Children with cerebral palsy have problems with muscle tone and/or muscle coordination. If they have too much tone, their bodies will be stiff. Too little tone results in floppy "rag doll" postures (see Figure 2). Those having spastic cerebral palsy most often have too little tone in their trunks and too much tone in their arms. They have difficulty sitting and using their arms or hands. For them, seating must be firm with sufficient trunk support so they will be able to move without fear (see Figure 3). Children with athetoid cerebral palsy generally have too little tone most of the time, with sudden bursts of too much tone.

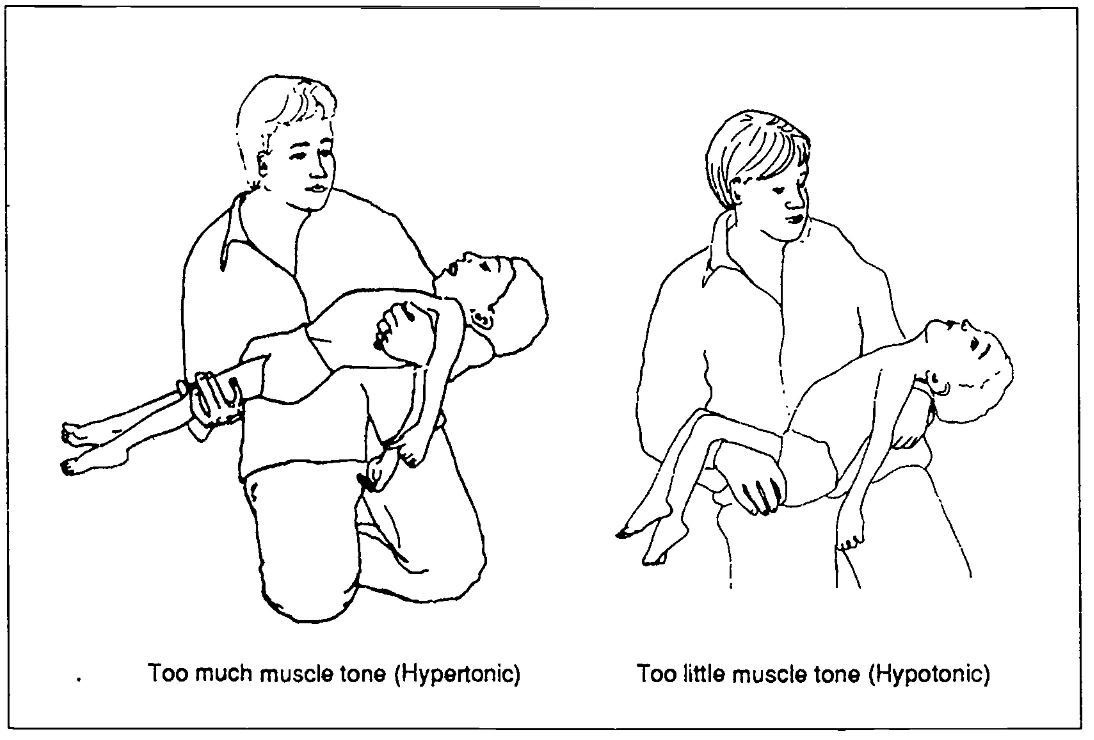


Figure 2 – Muscle tone problems

In these cases, the seating system should offer firm support and should restrict some of the extra movement. These abnormal tone patterns vary in degree from mild to severe and affect the amount of physical control the child has to perform functional activities.

Children with cerebral palsy also must deal with primitive motor patterns that resolve at an early age in children developing in a more typical fashion.

- An example is the asymmetrical tonic neck reflex (ATNR) (see Figure 4). When the child looks to one side, that side of the body extends while the

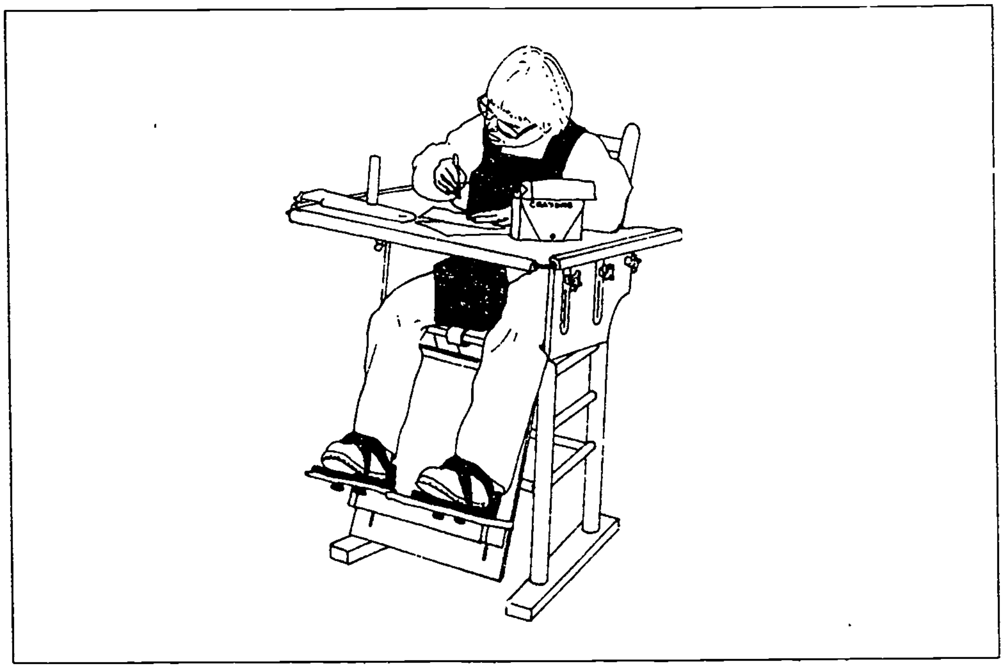


Figure 3 – Firm seat with additional positioning devices—chest support, medial thigh abductor, foot positioners

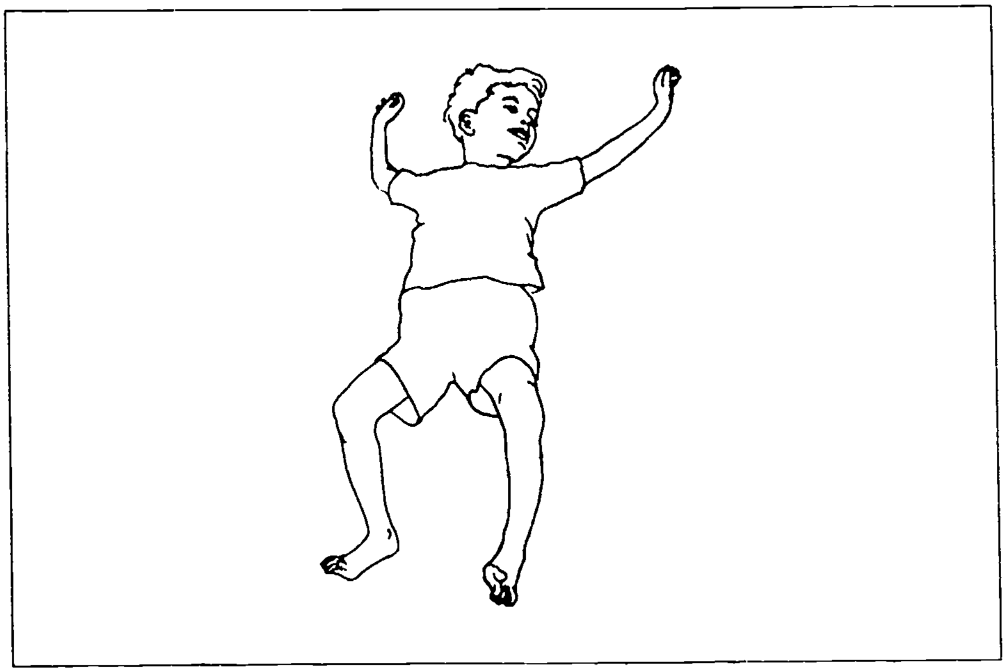


Figure 4 – Asymmetrical tonic neck reflex (ATNR)

other side flexes. In normal babies, this helps them look and reach for an object. In children with cerebral palsy, the pattern becomes fixed and can result in spinal curvature and a lack of separation of the movement of the head from the response of the body. Every time they look to the left, the left arm and leg straighten and the right arm and leg flex; the opposite occurs when they look to the right. To cope with this movement pattern, positioning must be oriented toward providing the children with as midline a posture as possible, with activities presented in the midline as well.

- Another example is the symmetrical tonic neck reflex (STNR), which causes the child's arms to bend and legs to straighten as the child looks down (see Figure 5). This makes it very hard for the child to remain sitting. These children tend to slide out of their chairs unless properly positioned to reduce the effects of the STNR. When they look up, their arms straighten and their legs bend. Once again, these are not voluntary motor patterns, although children sometimes use them to place their hands or alter their posture. If a child has a strong STNR, the teacher might position his or her work on an easel. This helps the child maintain a good sitting posture, because the child does not have to look down (see Figure 6).

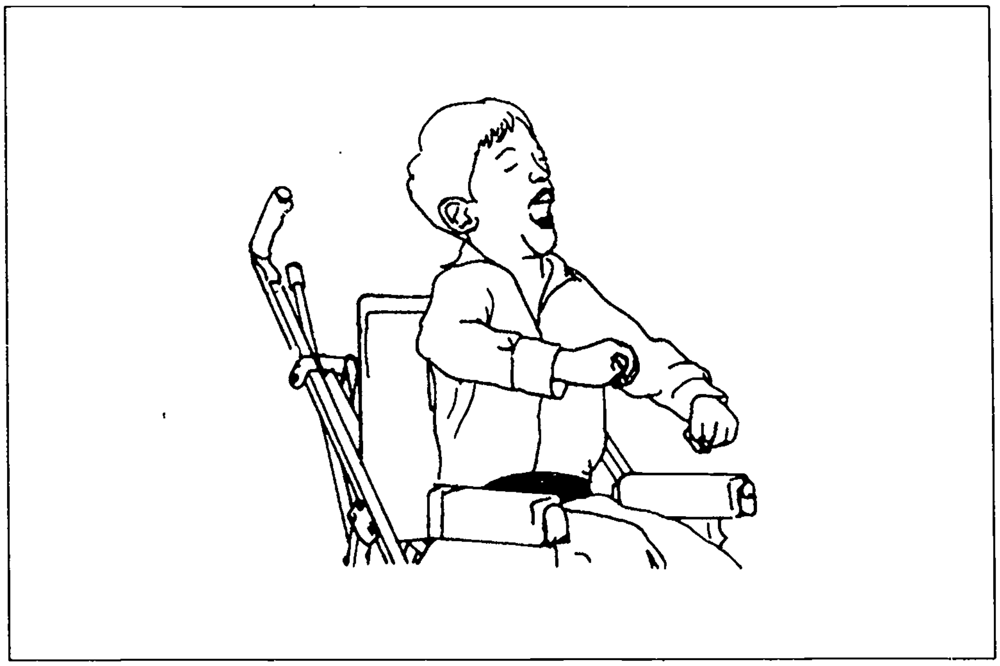


Figure 5 – Symmetrical tonic neck reflex (STNR)

Figure 6 – Child's work is placed on an easel to decrease chance of initiating STNR

- The tonic labyrinthine reflexes, prone and supine, primarily affect the child's tone as a result of changes in the orientation of his or her head in space. If the head is forward of the vertical position, the tonic labyrinthine reflex prone (TLRP) is in evidence (see Figure 7). There is flexion in the arms, legs, and trunk. If the head is behind the vertical position, the tonic labyrinthine reflex supine (TLRS) dominates with the extremities and trunk going into a predominantly extended or straightened position (see Figure 8). When deciding whether a child should sit upright or be tilted or reclined, the presence and strength of the tonic labyrinthine reflexes need to be considered to achieve as normal a tone as possible.
- Another important influence on seated posture is the positive supporting reaction that relates to the position of the feet. If there is pressure under the balls of the feet and the child has a positive supporting reaction, there will be an increase in extensor tone in the lower extremities, including the pelvis. This will make it very difficult for the child to stay bent at the hips in a stable sitting posture.

Not every child exhibits every reflex, and the intensity will vary by child. A teacher and family can consult with the child's clinicians to determine management procedures that will minimize the effects of these reflexes on the child's posture. These reflex patterns, as might be assumed, also affect a child's ability to activate a switch or participate in any activity that requires body motion.

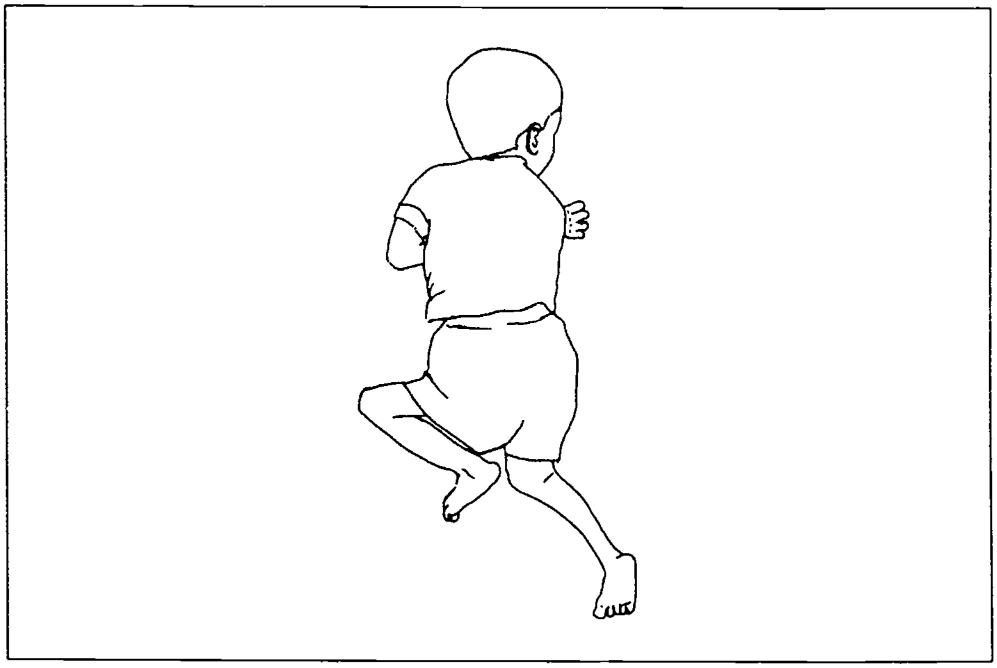


Figure 7 – Tonic labyrinthine reflex prone (TLRP)
(When lying on his stomach, child's arms and legs bend)

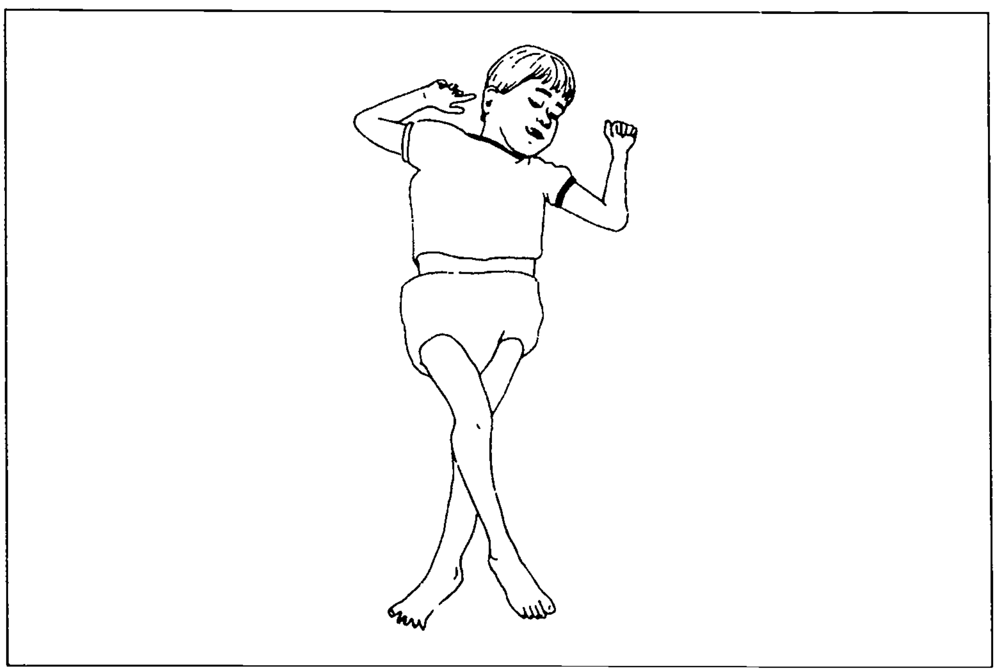


Figure 8 – Tonic labyrinthine reflex supine (TLRS)
(When lying on his back, child's arms pull back and legs straighten)

- We must be aware that, in some cases, seating may not be sufficient to deal with a child's orthopedic condition. If deformities exist, the team must determine if they are fixed or flexible and whether seating can really make a difference. If not, they may recommend referral to an orthopedic surgeon.
- Although the upright position is most helpful for school-related activities, the medical implications of sitting upright for extended periods must be considered. A compromise in seating position or periodic changes in seating positions throughout the day may be in order. In some cases, the seating for a wheelchair may need to involve a tilt or recline posture. The team will make this decision.

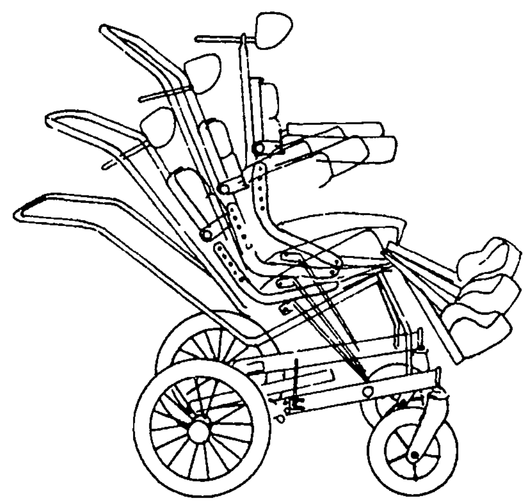


Figure 9 – Tilting of the total seating system

- **Tilt** – The total seating system is tilted in space (either forward, upright, or, more frequently, backward) and the back-to-seat angle remains constant (see Figure 9).
- **Recline** – The seat remains at a constant position and the back is reclined so that the back-to-seat angle increases.

Uninformed people tend to tilt a child too far back, thinking he or she will be more comfortable, without realizing that this position sometimes causes the back extensors to work harder. An increase in back extensor tone makes it difficult to bring the arms forward to the midline and forces the child to work against gravity to lift his or her head. Thus, the child must expend more effort to see and participate in classroom activity. In the tilt position, most children find it easier to allow gravity and high tone to hold them in the seat in a very passive posture. Also, we need to realize that many children with cerebral palsy have the most postural control when sitting upright with their hips and backs at a 90 degree angle. More than a very minor recline may result in an increase in tone about the pelvis with hip extension, causing the child to slide out of the chair.

The provision of a proper seating system will enhance the child's functional abilities. Improved posture will allow the child to focus attention on classroom activities. It will also provide an added security and stability that will enable the child to use his or her hands for eating, activating a communication device, using a computer, manipulating classroom materials, or playing (see Figure 10). In selecting technology for young children, it is important to remember that one device can never meet all the needs of an active, growing child. Besides the primary seating system, there are other devices (referred to earlier) that can provide access to many activities.

Figure 10 – Proper seating for play activity

Psychosocial Considerations:

- Equipment should look like it was designed for a young child, not like a scaled-down version of a product for an adult. Many wheelchairs are available in colors and styles that appeal to children (see Figure 11), and children should be allowed to choose (when possible) the style and color they prefer. Equipment that peers find acceptable and even "neat" greatly facilitates peer interaction. Children are better accepted by the public if they sit upright and are facing forward (i.e., people should see the child first and notice the technology second). This presentation will promote positive interaction, thus reinforcing feelings of self-worth.

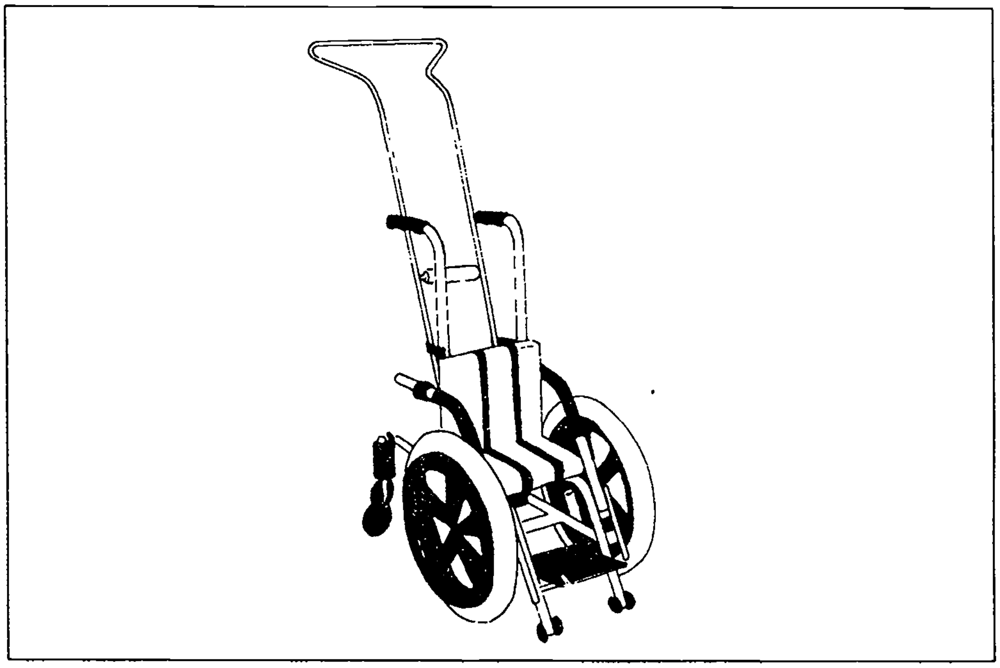


Figure 11 – Wheelchair designed for a young child

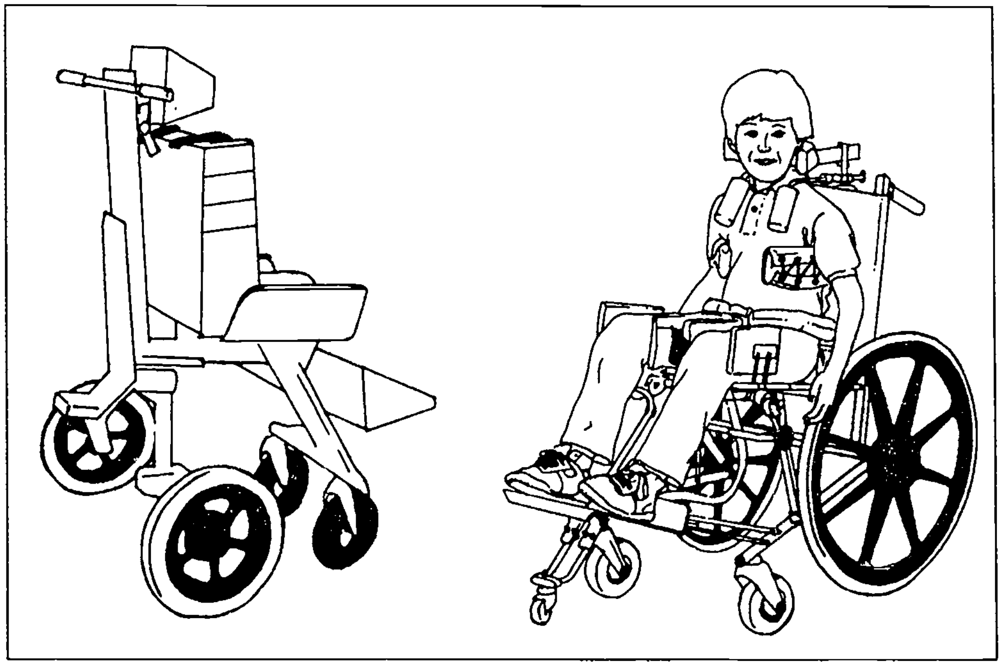


Figure 12 – Lightweight systems for easy transportation

- Family life-style must also be considered. If the family is active and participates in community activities, the seating and mobility system should be lightweight for easy transportation (see Figure 12). The family should make the decisions regarding fabric covering for seating systems and wheelchair upholstery. The family must also be able to manage the complexity of the various components and be able to adjust the components as necessary.
- When well-positioned in comfortable seating systems that are easily transported and attractive, children with disabilities are more often included in family and school outings. This gives them opportunities to meet and interact with many people. For nonspeaking children, the inclusion of augmentative communication systems as an integral part of their technology system (see Communication Module) also alerts others that the child has something to contribute.

Economic Considerations:

Funding is an important issue. Ideally, one would select the best system for the child at the most reasonable cost. However, primary decisions should not be made on cost alone, as there are creative ways to finance technology. Thus, essential features, such as tilt systems for some children or powered mobility for others, should not be dismissed purely because of financial considerations. At the same time, the most expensive equipment with the most features is not always the best choice for certain children. Another important point to remember is that prices for a given piece of equipment may vary, so it may be worthwhile to compare different manufacturers' prices before purchasing the equipment.

Growth Considerations:

A system will usually fit a child for two to three years, barring major changes in weight or physical condition. All technical devices should be reviewed on an ongoing basis. Children grow and if the seating system is to be effective, it should grow with them.

Height Considerations:

Height selection is often dependent on the mobility base that is chosen. Usually, because children cannot use the same device to be at floor height with peers and to eat at the family table, there must be some compromise in the selection of the base. Although several mobility bases now exist that offer this height adjustment (see Figure 13), they are expensive and technically sophisticated. An alternate approach might be to prescribe the seating system at the standard wheelchair height and, wherever possible, provide alternate positioning devices for other specific activities (see Figure 14). For example, a small classroom chair can be modified with a wedge seat and a lapbelt to allow the child to sit with peers during table activities in the classroom.

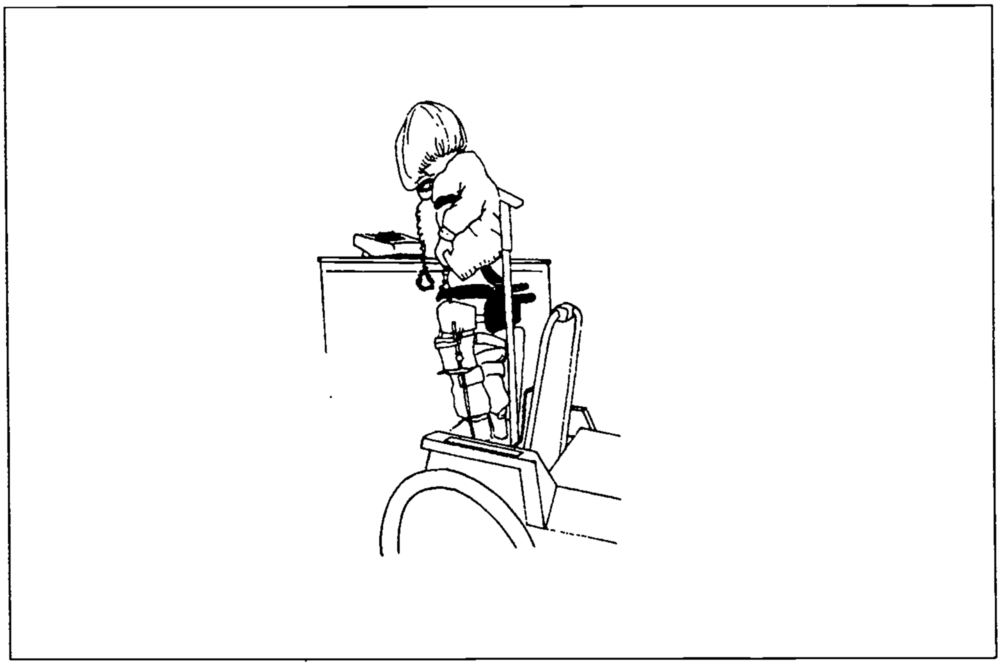


Figure 13 – Positioning system that allows for height adjustment

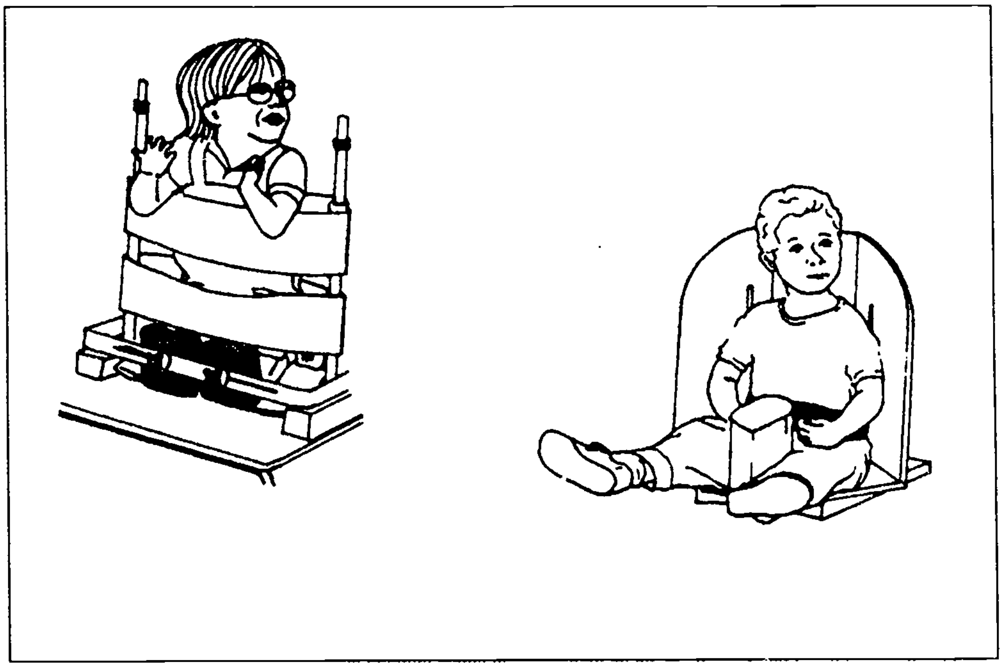


Figure 14 – Alternative positioning devices

Practical decisions must be made when selecting the most appropriate equipment for each child. Taking into consideration the technical needs of the child, choices must be made with regard to what is available, what the child will be able to tolerate, and the amount of time that teachers, assistants, and family have available to deal with the technology. Too much technology can tip the balance of acceptance and force families and teachers to reject an entire technology intervention program.

Using the Seating System

Once children are provided with the technology, those who work with them on a day-to-day basis must determine how it can be used most effectively. Physical and occupational therapists can help by teaching how to

- perform basic maintenance on the chair,
- place the child in the system,
- schedule regular reviews for growth or adjustments,
- determine the length of time the child should sit in the chair at one time, and
- alternate positions.

Overall, families and teachers can be alert for

- skin redness that does not disappear in 15–20 minutes;
- the child's level of alertness or agitation;
- indications that the child has grown, which would render the device too narrow or too short;
- changes in the child's physical condition (e.g., worsening of a spinal curve); and
- changes in functional condition (e.g., child fatigues frequently throughout the day).

Such conditions may require referral to the seating team for consideration of changes in the technology.

Most children can begin using a new seating system immediately. For those with sensitive skin or with major orthopedic problems, it may be necessary to gradually build up the time they are in the seating system. Starting with 30 minutes (generally), they should eventually be able to tolerate several hours before a position change is necessary. The exact program will be provided by the child's physical or occupational therapist, who will also provide the child's follow-up program to the family, teachers, and teacher aids. Whenever possible, the physical or occupational therapist should provide actual training sessions to school personnel.

Following is a simple checklist that may help determine, on any given day, if a child does not seem comfortable in his or her seating system. Check to see if

- the child is tired,
- his or her pelvis is as far back in the seat as possible,
- the seat belt is properly fastened,
- all positioning belts are fastened,
- the tray is in place,
- seating supports are in place,
- the chair is at the correct angle, and
- all attachments to the frame are secure.

If this check does not locate the problem, call the seating specialist on the child's team.

Appendix B lists manufacturers and vendors of positioning and mobility technology. By contacting local vendors or calling the manufacturers directly, one can usually obtain this technology on a trial basis. The appendix also contains references on positioning and mobility topics.

Chapter IV Technology for Access

We position children to make them comfortable and to help them be optimally functional. Once provided with sitting stability, children with physical and multiple disabilities can begin to access other technology, such as augmentative communication devices, computers, toys, and so on. For children with minimal physical disabilities, the positioning alone might make it possible for them to use their hands well enough to play with a toy or eat a cookie by themselves. For children with severe difficulties with tone and/or coordination, positioning alone may not be sufficient.

For example, some children with spastic cerebral palsy experience such severe contractures of their elbows that they cannot place their hands down on a switch. Some children who have athetoid cerebral palsy cannot control their movement patterns sufficiently to accurately place their hands in one spot. Children may have muscles that are too weak to press a switch even if it is under their fingers. The ability of such children to access communication devices, battery-operated toys, household appliances (such as popcorn machines or blenders), or classroom equipment depends upon their ability to operate an access system that will then operate the device. For example, the child who learns to control a joystick can then use the joystick to operate a powered wheelchair, an augmentative communication device, a computer, or, in some cases, all three. The child must be placed in an upright position to operate the joystick. This may enable the child to place his or her hand over the joystick and push it with control in various directions.

Children who do not have functional use of their hands (even with proper positioning) can learn to operate a joystick with their heads, feet, elbows, or other body parts. If their disabilities prevent use of the joystick, the children can learn to operate single or multiple switches that can then operate other technical devices. It is almost always possible to locate at least one control site on the body that can be matched with switch technology, thus enabling the child to operate devices in the environment. Proper positioning is an essential first step in making technology accessible to the child.

One of the most difficult decisions in providing a child with assistive technology involves determining exactly how the child is going to operate a particular device. Questions to ask include:

- What will the access system be (e.g., a keyboard, a single switch, a joystick, several switches, or a combination of access devices)?
- What part of the body will be used to operate the access system?
- Where should the access system be placed for the child to use it most effectively?

We will now explore the different aspects of technology for access, including

- the child's disability,

- the body part and the motion that will be used to operate the technology,
- how and where the access technology will be mounted, and
- the type of switch or access technology that will be used.

Considerations for Selecting Access Technology

Motor Problems

As an example, we are going to look at children with cerebral palsy or head injuries. If they are diagnosed as spastic, then it is likely they will have restricted range of motion and may be unable to reach the total length or width of their wheelchair tray. Therefore, proper placement of any access device would be very close to the body, preferably near the center of the tray or near the hand the child will be using.

Children with a diagnosis of athetoid cerebral palsy will have the most control with their arms totally bent or totally straight. Many of these children do well with their access devices positioned at the far edge of their trays and to the side, where they have the most control. It is important to remember that children with severe athetosis often have better control of their feet and legs than their arms; this could offer further options when arm control seems impossible.

Some children with very low tone are referred to as "floppy children." They find it difficult and tiring to move at all, let alone to use their bodies to operate an access device. The placement of switches must be carefully planned so that the least amount of energy is required to place the hand and to operate the device.

Many children with head injuries and cerebral palsy also have cognitive and sensory impairments. Choosing access controls and placement for these children becomes even more complex, and advice from a variety of specialists, such as vision experts, audiologists, occupational therapists, and so forth, is in order.

Pain

Children with conditions such as juvenile rheumatoid arthritis experience considerable pain in their bodies, especially their hands. The pain limits the range of motion the children use and also leads to fatigue. Switches may have to be mounted in such a way that they can be repositioned by the child to the least painful position at various times during the day. In addition, switches selected for these children should require minimal pressure or jarring of th joints to avoid irritation.

Weak Muscles

Children with muscular dystrophies, such as Duchenne Muscular Dystrophy or Amyotonia Congenita, often have such weak muscles around the shoulders and arms that they cannot place their hands over the control. Once their hands are placed on the switch or the keyboard, however, their motor control is fine. Therefore, these children may need overhead slings or forearm support just to place their hands in a functional position. Also, because of fatigue, the keyboards or controls may need to be very small and require minimum motion and pressure to operate.

In this category, we must also mention children with arthrogryposis, whose muscles are often inflexible and unusable. They have both limited range of motion and are unable to move their hands where they want them. It is not muscle weakness that limits these children; it is the absence of muscles. However, the clinical solutions are similar to those used with children with dystrophies.

Sensory Impairments

Children who are blind or visually limited or who have hearing impairments often have the fine motor skills necessary to operate switches and keyboards in a variety of different locations. The challenge with these children is to provide an access system that takes into account the skills they have. For example, children with visual problems may need large print, raised, or Braille letters on their keyboards. This will be discussed further under the section describing the input and output characteristics of access devices. Access technology must be designed so that it does not interfere with other items, such as hearing aids or glasses. For example, a switch should not be placed to the side of the child's head if pushing the switch displaces the hearing aid. Occupational therapists can provide suggestions for managing the child with special tactile needs.

Mental Retardation

Children with mental retardation may also have motor deficits. For some of these children, the motor deficits are minimal; they have the motor skills necessary to operate access devices that are placed in front of them. They must learn what the access device is for and how to use it in a functional manner. For children with more extensive motor deficits, the approach should be multifaceted and include consideration for both the motor and cognitive deficits.

Children with cognitive or perceptual disabilities who do not yet understand concepts such as cause and effect or choice making may need to begin by using a very simple switch. For example, they might begin by using only one touch switch to make a remote control car go forward, progress until they can use four switches to move the car in four directions, and finally learn to use a joystick. Teaching strategies traditionally used with these students can be applied to learning switch operation. Training could be incorporated into classroom activities and reinforced at home and during therapy sessions.

Summary

Thus, it is important to understand a child's strength, range of motion, durability, coordination, and mental abilities, since the combination of these factors will determine the child's speed and accuracy in learning to operate an access device. If a child can use a thumb to push the keys of a computer keyboard but makes errors and expends tremendous energy, he or she might function better using an alternate keyboard that requires only gross motor placement. It might take the child more time, but the work would be more accurate and the child would become less fatigued and likely less frustrated.

Selecting the Control Site

Whenever possible, children, like everyone else, prefer to use their hands or arms for manipulation. If, after a number of trials, it is obvious that hand or arm placement is too difficult for a child, other body parts that the child can voluntarily control should be considered. Voluntary control means that the child can move the selected body part intentionally, and that excitement and abnormal body tone do not prevent or alter the desired motion from taking place. For example, recommending that the child use his or her foot to control a joystick with a forward foot motion to make the powered chair go forward may be dangerous if every time the child tries to speak, extensor tone increases and involuntarily moves the foot, and therefore the chair, forward. If the body part of choice is the head, it is preferable that switches be placed to the side or back of the head so that people meeting the child will see the child first and the technology second. Feet, knees, shoulders, elbows, eyebrows, eyes, and so forth, have all been selected as control sites for specific children. The decision is individual and must be made by the team following a thorough evaluation.

Mounting the Device

The decision on where to actually mount the switch(es) is, of course, somewhat determined by the body part chosen as the control site. Placement on the wheelchair tray, belt, person, desk, and so forth, are all options. If children need to access different technologies at the same time or in sequence, the team may need to coordinate a variety of switch placements. If the head is going to be used, then the switch(es) must be mounted where head motion can activate them. If the hand is chosen, the switch(es) can be mounted on the child's tray or on the armrest of the chair where they can be easily reached.

Mounting switches is not always simple. They must be mounted securely and yet not interfere with getting the child in and out of the chair (see Figure 15). The amount of stability and strength required will depend on the strength of the child and the weight of the device. Severely disabled or older children with athetoid cerebral palsy will need much stronger mounting hardware than younger children with amyotonia. Larger devices or devices that must be mounted some distance from the child require stronger mounting hardware. Wires attaching the controls to the device must not be stretched or tangled as trays are taken on and off. Wires attached to controls must not interfere with wires from assistive listening devices. Occasionally, the ideal control location becomes impractical strictly because of the mounting challenge.

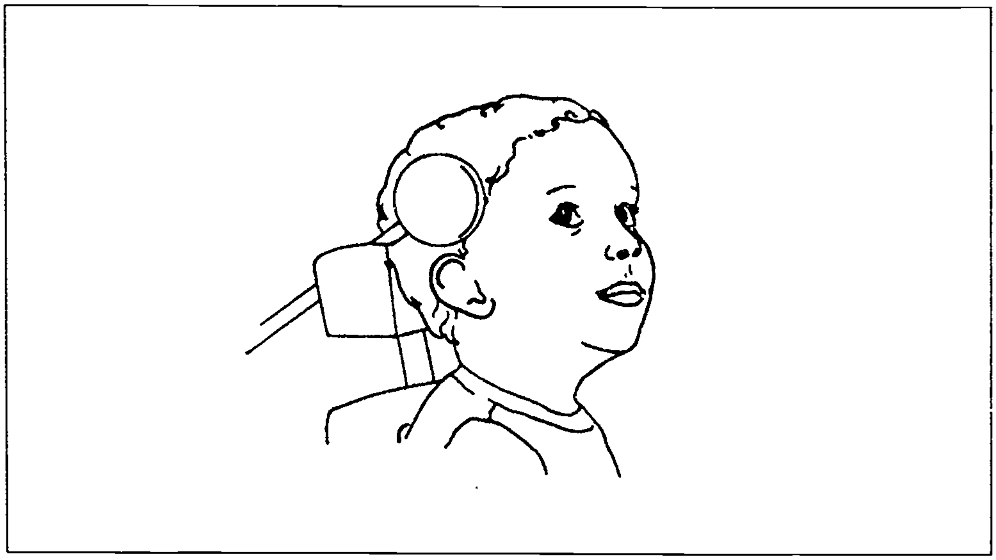


Figure 15 – Head switch mounted to side of child's head

The position of some control systems must be adjustable to allow for the changing functional or physical needs of the child. As mentioned earlier, the position of the switch might have to be altered if the child fatigues during the day. Or, for children who can use their hands in only one specific location, the control for the powered wheelchair and the augmentative communication device must be in the same location if it is important that the child be able to change from one control to the other by him or herself. For example, the child who uses a TouchTalker and a wheelchair joystick in the exact same position must have mounting hardware that can slide the communication aid out of the way when the child needs to use the joystick to move the wheelchair.

The best way to select a switch-mounting system for at least a trial basis is to work with a physical or occupational therapist and one of the commercially available switch-mounting kits, such as one from Zygo Industries or Adaptive Communication Systems (ACS). Several different sites and mounting strategies in the approximate location of choice should be tried until the very best locations with the least complicated configuration of mounting hardware is found. It is necessary to determine if a stationary mount is needed (as for a computer keyboard when the keyboard will stay on the desk) or if it must be portable and move with the child (as for an augmentative communication device). The child must be able to operate the switch at all times. If the child's position changes, it is important that the switch remain within reach.

Selecting the Access Device

The final decision that must be made involves the selection of the actual device the child will use to activate the needed technical devices. Will it be a joystick, single or multiple microswitches or touch switches, or switches activated by breath, light, body position, or change in body position? Rather than providing a comprehensive list of available options that would be incomplete and out-of-date before this publication is printed, we will instead provide categories from which to choose and factors to consider, related to both the child's needs and the characteristics of the controls themselves. A more complete coverage of this topic can be obtained in Appendix C. A description of ABLEDATA, a computerized index of manufacturers and their devices, is included in Appendix A.

Types of Input Devices

All input devices open and close a circuit and can, therefore, be called switches. However, there are various activation methods, sizes, and other characteristics that help differentiate the type of switch or input device.

- **Keyboards.** Keyboards can be purchased or modified and can be very small (mini) or very large (maxi) (see Figure 16); they can also be custom designed to meet individual size and design criteria. In addition, pad configurations can be programmed for the individual.
- **Pointers.** Pointers (often mounted on headbands) can direct or sense light or infrared beams that activate the switch remotely.
- **Voice-activated switches.** A person is able to use speech to operate a device.
- **Eye-motion switches.** Eye motion can be used to activate a switch that tracks reflection off of the eyeball.

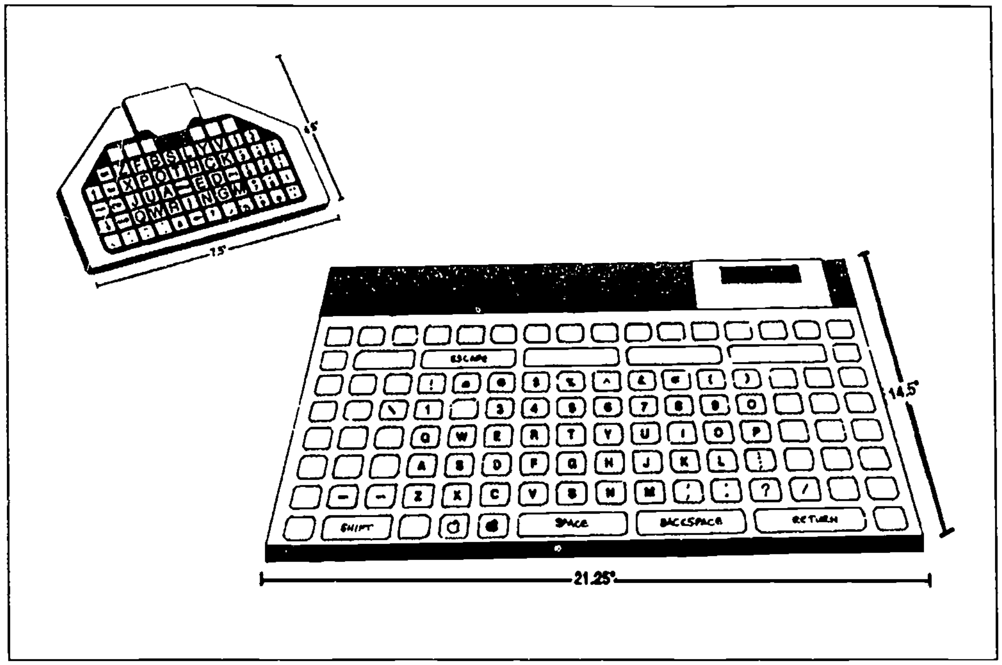


Figure 16 – Examples of keyboard sizes and configurations

- **Joysticks.** There are two types of joysticks. With the proportional joystick, the farther the stem is moved from the center, the faster the device will move in that direction. With the microswitch joystick, the stem can be moved in one of four or eight directions to initiate distinct movements. The speed is constant no matter how far the joystick is moved from the center; the chair will pivot in a circle instead of going faster.
- **Microswitches.** Microswitches can be single, double, or multiply mounted; large or small; activated by touch, pressure, air (pneumatic), mercury (a change in orientation), mouse/track balls (a change in motion); or wheels/paddles and EMG (using muscle signals to operate the switches).
- **Touch switches.** Touch switches can be single, double, or multiply mounted, come in large or small sizes, and are operated by simply touching the switch. The components of the switch do not move; therefore, less motion is required to use a touch switch than to use a microswitch.

Control (Switch) Characteristics

Besides knowing the types of switches that are available, it is important to understand the characteristics of the different switches to be able to compare similar products.

- There may be several switches that operate with touch, but each is likely to need a different amount of pressure. For the child who is weak, the switch with the least amount of pressure is best. For the child who is using strong, gross motor control to operate the switch, there is value in ordering a switch that requires more pressure to operate.
- Some switches click when they are operated. This is a very important feature for children with visual limitations. It also provides the cognitively impaired child with immediate and more concrete feedback that the switch has been activated.
- Some switches are more durable than others, which is important for children who use their feet to activate the switch.
- Some switches give very good visual feedback (large print or good contrast between the foreground and background), which is important for children with visual, sensory, or cognitive disabilities.

The selection of the switch itself can be critical to the functional operation of the end device. Catalogs can be helpful, but often do not provide information that helps clinicians and teachers compare features. Asking specific questions of physical therapists, occupational therapists, dealers, and manufacturers can provide the necessary information. Dealers may also provide devices for use on a trial basis.

Although the cost of a device should not be the primary deciding factor, it must be taken into account in the decision making process. The least expensive device that provides the appropriate options should be the device of choice.

Selecting and Implementing Access Technology

Lee and Thomas (1990) provide a flow (listed below) for the assessment and provision of technology used to access technical devices. These are the steps that a team is expected to follow as a child is being evaluated.

- **Gather and analyze information** – The team will interview the child, family, and teacher and to determine what they want to operate using the access device, what the child's functional abilities are, and in what environments the child will be using the technology.
- **Observe** – The team will observe the child as he or she attempts to move or to participate in activities. They will ensure that the child is in the optimum position for using motor patterns as they apply to functional use. The team may determine needed technologies or skill areas that have not yet been considered and that bear further investigation, such as the child's hearing or vision.
- **Survey** – The team will survey the child's abilities to operate a variety of switches in a variety of locations.
- **Propose** – At this point, the team will propose the access method(s) of choice, taking into consideration parallel choices. For example, they may recommend that the child use scanning at this time, but work toward direct selection for purposes of speed as the child gains greater skill and control.
- **Personalize** – The team will mount the switch of choice for the child. They may need to determine if one switch with one end device will be sufficient, or if it will be necessary to coordinate a variety of switches for the operation of different technologies.
- **Train** – The team will train the child in the operational use of the switch and the device that it is used to operate. They will evaluate the switch using one of the child's favorite toys rather than the actual end device, thus separating the motor operation of the switch from cognitive tasks that would be a part of operating the end device (e.g., understanding a computer program or letter recognition). For example, to see if the child can operate a single switch to use a scanning device, they will first use that single switch to operate a simple favorite toy. This way, they can evaluate the child's ability to use the switch while not adding to it the cognitive task of scanning. They will show the child how it works, ask the child to make it work, observe the movement patterns involved from beginning to end, including how the movement affects total body posture, and repeat the process several times to establish a comfort level. The amount of training needed will vary with the complexity of the access device and the end technology as well as the cognitive and motor abilities of the child. Motor skills can be taught, but often a period of time is required to practice the skill.
- **Implement** – It will then be up to families and teachers to integrate the switch and the device into the home, classroom, and community.

- Monitor – Systematic monitoring of the use of the technology and its impact over an extended period of time is absolutely essential.

Following this proposed format encourages families, teachers, and clinicians to consider all necessary phases of service delivery. For an illustration of the process just described, refer to the case study provided in Appendix D.

Environmental Control

Why It Is Important

Children of all ages control their environments in various ways, including crying, throwing temper tantrums, refusing to perform a requested task, independently completing a task, smiling to gain another's cooperation, and so forth. Some of these behaviors are ones that families and teachers want to encourage, and some are not.

At two years of age, children typically begin to separate their will from the will of their family members. They verbally refuse to perform expected tasks or run away as an avoidance technique. Children with physical difficulties often compensate for their lack of motor abilities by developing behavioral control systems. That is, instead of running away from situations of which they do not wish to be a part, they throw temper tantrums to disrupt the situation so that they will be removed or the situation terminated. Or, they may simply refuse to become involved by looking away or looking down; some might refer to this as passive/aggressive behavior. Over time, a child can use a whole repertoire of such inappropriate behaviors to manipulate people in the environment. Therefore, from a very early age, these children must be provided with acceptable ways of controlling their environments. It is easier to support the development of appropriate behaviors than to try to change inappropriate ones

Once the control system best suited to the child is chosen, the child's ability to control the environment can be broadened tremendously. For very young children, control can involve playing with a toy, turning a tape player on and off, or turning their room lights on and off. With relatively simple modifications to toys or lamps children can perform these tasks with switches (see Figure 17). As they get older, the child's use of controls can be expanded to include technology such as the remote control for the television, computer operations, home alarm systems, and telephones. As they become teenagers, they can use commercially available environmental control units (ECUs) to help them live independently. The challenge is to begin the process of allowing the child some measure of independence and control over the environment as early as possible. This will establish living patterns that encourage independence. Control of simple technology when children are two years old develops the foundation for skills that increase independence and productivity in adulthood.

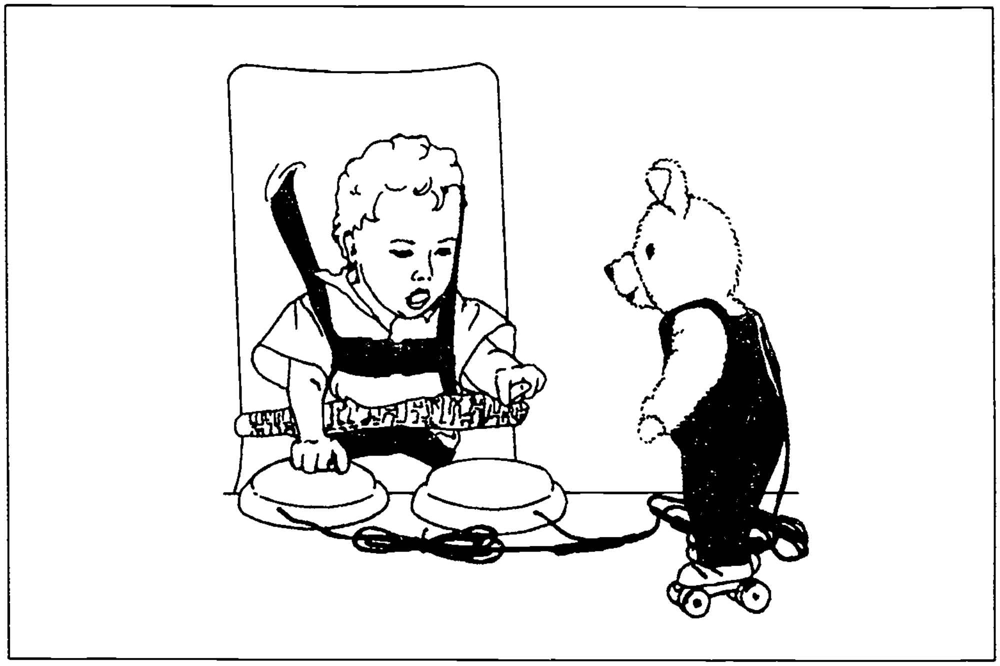


Figure 17 – Child using microswitches to activate a toy

Selecting the Technology

Deciding which environmental control technology the child will use involves the same steps as the evaluation for other technologies:

- The child must first be well positioned.
- The functional system of control that is chosen should take into consideration body motion, body control site, and the technology itself.
- The end technology the child wishes to control should be chosen. These must be age-appropriate and considered important by the child and others in the environment. For example, very young children love to turn lights and tape players on and off. However, the family might want to wait until the child is four or five before considering the operation of a telephone and even later for a home alarm system. Families and teachers must look to the future to understand why a 3-year-old should be operating on-off switches of certain systems when it seems so much easier and cheaper to operate the items themselves.
- Training depends on the age and cognitive skills of the child and the complexity of the devices to be controlled. Individuals installing the devices at home or at school must be sure that everyone knows how to use them effectively, even after the installer has left. As with all technology, ongoing review of the child's needs and the best current technology to meet those needs is essential.

Chapter V Technology for Mobility

All children move. Within the first year of life, most will roll, scoot, crawl, creep, and then begin to walk. Being mobile fuels curiosity and a desire to master the environment. Children with physical disabilities are born with this desire to move. If, over time, their efforts are unsuccessful, they either become complacent, dependent (relying on others to move them), or ill-tempered, as they are constantly frustrated by their lack of independence. It is critical to begin intervention early to prevent these patterns from developing. Assistive mobility technology can help very young children to crawl, creep, walk, and, in some cases, move with a wheelchair or other wheeled device. Using technology compensates for the child's inability to move and promotes overall development.

Basic Principles

- Mobility technology is appropriate for children whose physical disabilities preclude functional, independent mobility or who have a delay in motor development that prevents timely acquisition of mobility skills. It can also be used for
  - any child who can walk but who is unable to keep up with his or her peers because of the amount of energy that must be expended or time required; or
  - any child who, when independently mobile, exhibits abnormal patterns of movement that may result in long-term medical or orthopedic complications.
- Intervention should begin as soon as it becomes evident that the child is not attaining motor milestones that would naturally lead to independent mobility. These typical milestones are
  - **4–5 months** – begins to roll;
  - **6–8 months** – crawls on stomach;
  - **8–9 months** – creeps on hands and knees, begins to pull to stand, and stands holding on;
  - **8–10 months** – some begin to walk on their knees and others begin to cruise holding onto furniture; and
  - **10–15 months** – begins to walk.
- Mobility devices should complement skills the child already has. If the children are 4 years old and can creep, it is appropriate for them to creep in the home or a limited school environment; however, they may need a mobility device to keep up with friends on the playground (see Figure 18).
- A mobility device chosen for play may be very different from a mobility device chosen for getting around.

- Play devices can be inexpensive and do not need to be customized. They should allow children to be creative and to express themselves (see Figure 19). Children can sit on, lie on, push, pull, climb onto, fall off of, or turn over on these wheeled devices. They can also facilitate a child's crawling under something.

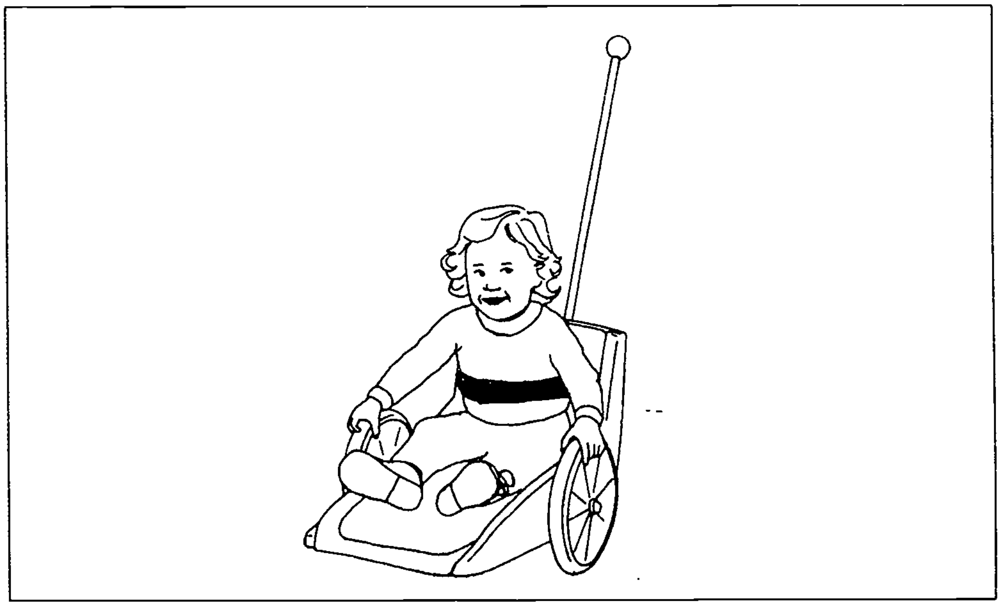


Figure 18 – Young child using a scooter to move around at floor level

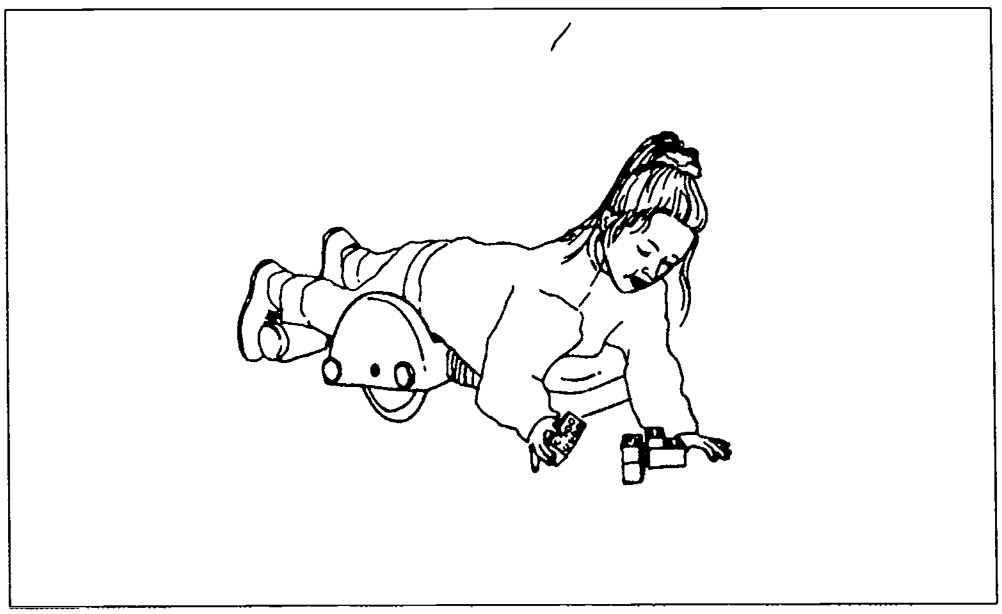


Figure 19– Mobility device for play

- If a wheeled play device is to serve as the primary device for getting around, enabling a child to get to the lunchroom and back, for example, then it must perform safely and reliably. Mobility devices, though often expensive and complex, are safe and allow for the child's participation in a variety of out-of-home and out-of-classroom activities.

- The ability to walk is dependent on the integrated skill development of the total gross motor system. Technology can be used to compensate for missing components of gross motor development and allows children independent mobility while they are still working on developing walking skills.

In this module, mobility refers to the ability to move through one's environment. It is not limited to walking. History in the habilitation/rehabilitation field has taught us that we cannot focus all attention, treatment, and energy on teaching a child to walk because there are many who will never attain that skill. The value of treatment toward this end, however, should never be underestimated, especially for children who have even the slightest potential to walk. But this thrust should not become so dominant that other areas of the child's development are neglected. Resources, time, energy, and finances must also go toward educating the child in the broadest sense. If walking is not functional in terms of energy efficiency at any point, then augmentative systems of mobility should be introduced on a temporary or permanent basis. Children should not be prevented from active participation in their world today because of goals for tomorrow. Parallel intervention should be considered (i.e., training the child to walk while providing a mobility device for the present).

There are two essential prerequisites to providing mobility technology:

- The child must have the desire to move. This is difficult to determine with children who have never had the opportunity to move. It can only be decided after the child has been given a thorough evaluation by a physical or occupational therapist and an opportunity to experience independently initiated mobility. This should be done even if a considerable degree of assistance is required initially to enable the child to move.

- The environment in which the child will be mobile should be friendly; that is, teachers, family members, and peers should want the child to move independently, and there should be adequate accesibility (e.g., ramps, if needed) to allow mobility inside and outside of the home or classroom.

Mobility Devices

There are two broad categories of mobility devices: (a) those that are propelled by hand (either by another person or by the child); and (b) those that are battery-operated.

- **Attendant-propelled manual** – a wheeled device that is propelled by someone other than the child. This is appropriate when the child does not have the motor skills to operate a self-propelled device independently and/or does not have the understanding or is not old enough to manage a powered system. It is also appropriate for special purpose travel (e.g., when the family members want a stroller for quick trips to the grocery store, or the teacher needs to transport the child to and from the edge of a swimming pool).

- **Self-propelled manual** – a mobility device that can be propelled by the child's hands, feet, or combination of the two. This is appropriate for any child who requires a mobility device and can operate the manual chair with sufficient efficiency and skill. It enables the child to be independent within the home, school, and community environments. Self-propelled devices can be conventional wheelchairs, ultra-light or sports chairs, tricycles, carts, and so forth (see Figure 20).
- **Battery-operated** – a mobility device that runs on batteries and is operated by one or more switches. The child must be able to operate a control system (one or more switches). Battery-operated mobility devices are appropriate for children who lack the motor abilities to efficiently propel a manual wheelchair. The child must have sufficient cognitive skills to accept the responsibility for operating a powered device (i.e., the child must have an awareness of dangerous situations regarding the system's balance, an acknowledgment that because of the system's power he or she could run into and hurt other children, etc.). Powered devices include conventional powered wheelchairs, powered bases, scooters, carts, or self-propelled chairs with powered units added on (see Figure 21).

Control Devices

If a battery-powered device is selected, then the type of control (switch) used to operate the device must also be selected. Control options commonly used today include

- a joystick,
- a single switch, and/or
- several switches.

New developments include voice-activated chairs or chairs operated by proximity switches that sense the position of the head and move in that direction.

The choice of switches for a powered chair follows the guidelines described in the access section of this module. However, because powered wheelchairs are moving, powerful, and potentially dangerous, extra attention must be paid to providing a very stable posture and a safe, reliable control system.

Selecting a Mobility Device

Overview

Mobility devices are first considered for young children when they become too heavy or awkward to be carried. A commercially available stroller is often the

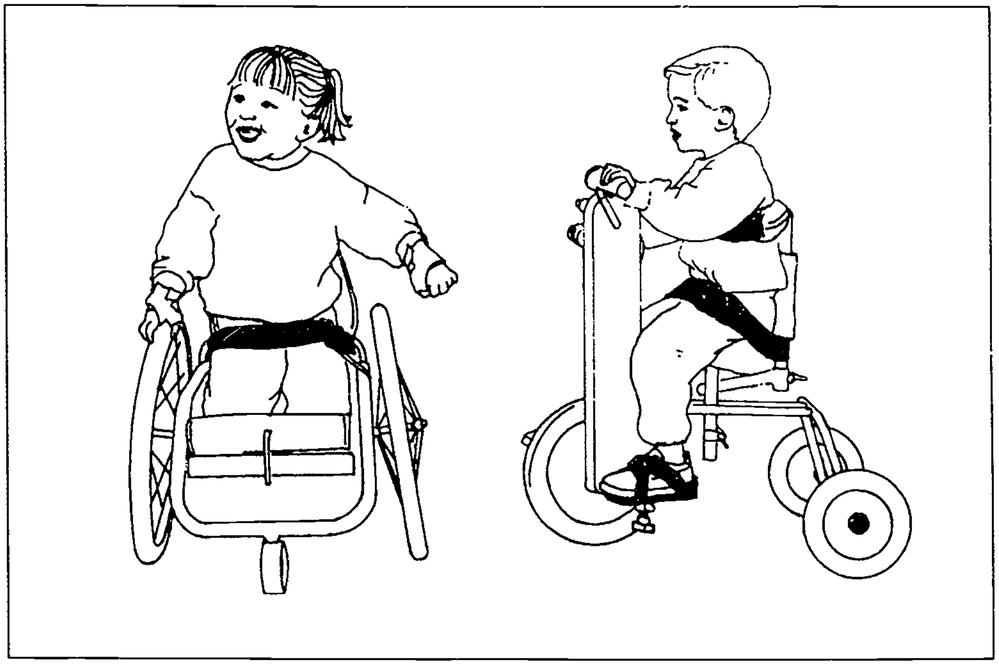


Figure 20 – Self-propelled manual mobility devices

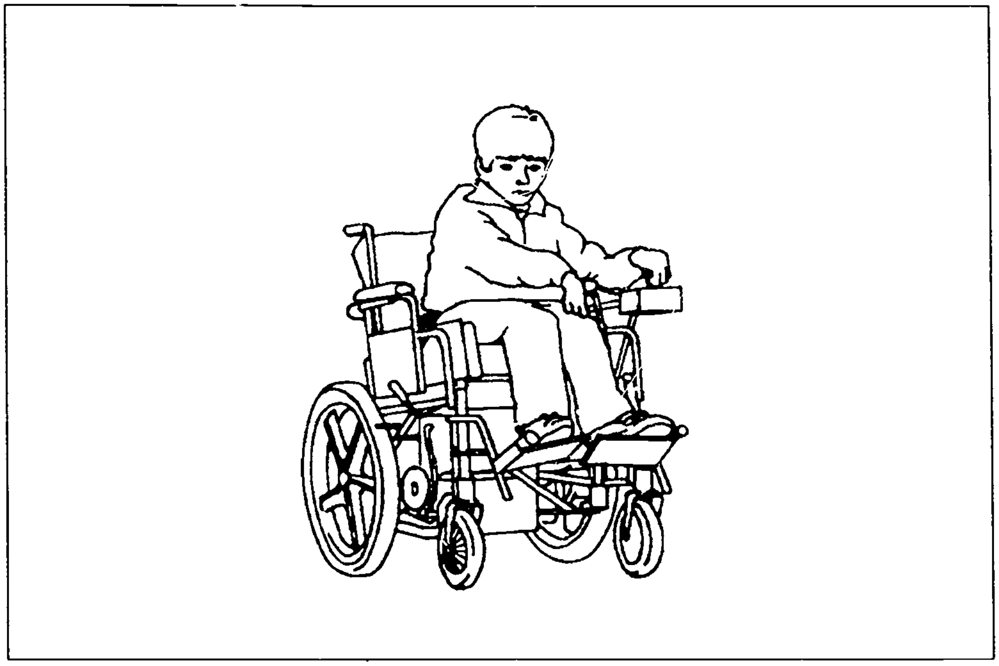


Figure 21 – Child using a joystick to operate a powered chair

mobility device of first choice. It works well for children with few physical problems; however, if children have high tone or orthopedic problems, families find the children constantly slipping out of the standard stroller. At this point, they begin their own modifications with straps and pillows. Replacing a stroller with a wheelchair is often an emotionally difficult time for families. For the first time they must acknowledge in public that their child has a disability. However, it is at this point that referral to a technical team for consideration of a personalized seating and mobility systems is in order. Because the mobility device becomes the base for the seating system, they should be considered at the same time.

Traditionally, young children were not considered candidates for powered mobility as the technology was thought to be too complex, expensive, and potentially dangerous. Also, it was felt that if children received powered devices for mobility, they would not try to use their own motor abilities. Research, however, by Butler (1986), Paulsson (1984), and Trefler (1986, 1988) has shown that children as young as 15 months of age can operate powered devices safely, that a variety of motor skills are increased when children can move about independently, and that children mature and become much less dependent when provided with powered mobility. Research on typically developing children (Campos & Bertenthal, 1987) indicates that they develop important cognitive skills, such as depth perception, through their experiences of moving about independently. For these reasons, it is very important that we all work diligently to provide independent mobility for children with disabilities as soon as possible.

Evaluation for the Mobility Device

When evaluating a child for seating and mobility technology, the team generally follows specific steps to determine the device that is most appropriate. Initially, before the child is asked to perform the motor skills necessary to propel the mobility device, the optimal seated position must be determined.

- The child's pelvis should be firmly fastened with a seatbelt into the seating system.
- Although the child is always given good midline stability in a seating system, this point is even more critical when using a powered chair. Sudden noises, changes in speed, and excitement can all initiate reflexes, abnormal tone, and patterns of movement that can be quite dangerous when the chair is in motion.
- Because of the potential dangers, additional stabilization, such as anterior chest supports or arm restraints, are sometimes recommended for the child learning to operate a powered chair. It may only be necessary for a short time until the child becomes proficient with the system.

To evaluate motor control abilities, the child is placed in the manual, self-propelled mobility device being considered, or in a similar device. The child is first shown where the wheels are and how the wheels move the chair and is then given an opportunity to move the chair. More than one trial may be necessary. The child's ability to drive the chair following instructions is then observed, along with the child's ability to move it in a functional manner. This entails moving indoors within limited surroundings on smooth surfaces and outdoors over longer distances covering rough terrain. The team notices the efficiency of motor control, endurance, and any deterioration of movement patterns. For example, the child who is exhausted after crossing a room is unlikely to get very far in a manual, self-propelled chair. Ideally, at least a portion of the evaluation takes place in the child's own home, school, and community. It is easy for clinicians to underestimate how successful a child can be when they are not familiar with the real distances and environments that the child may encounter in a typical day.

A manual device is deemed appropriate if the child is able to move the device at a functional speed without excessive effort and in appropriate directions. If the child does not understand what he or she needs to do to move the chair, then two steps are followed:

- First, the child is provided with the opportunity to learn the skills.
- If, over time and with extensive training, the skills are not acquired, an attendant-propelled mobility device will be recommended, along with reevaluation at a later date for possible independent mobility.

If the child is too physically disabled to operate a manual, self-propelled wheelchair, then a battery-operated device should be considered. For example, the child who has a diagnosis of hemiplegia (has better control over one-half of his or her body) may only be able to push the chair in circles. Or, the child who has quadriplegia (has problems with all four limbs) and experiences extremely high tone as a result of cerebral palsy whenever movement is attempted may be unable to operate a manual chair.

General evaluations for powered mobility should include the following considerations:

- **Necessity** – Is it really needed, or can a manual system provide the needed mobility?
- **Family and child desires** – Sometimes children are ready for powered devices before the adults in their environments.
- **Environmental issues** – Are the home and school accessible? Is transportation available both to school and for family outings? Are there adults available who will remember to change the batteries, check the air in the tires, and provide basic chair maintenance?
- **Child skills** – Cognitive ability and readiness to assess situations as safe or unsafe must be considered along with the child's motor abilities.
- **Length of time involved** – For powered mobility, the evaluation process is more complex and takes much longer because the children who need these devices have more severe motor problems and require complex seating systems to facilitate maximum control.
  - It is often necessary to customize placement of the wheelchair controls and to customize the control equipment itself.

- It is also necessary to ensure compatibility with other technologies, such as augmentative communication devices.

There are two approaches to evaluating for powered mobility:

- Using a computer-simulated approach, a child operates a wheelchair control to manipulate a cursor on a computer screen to do simulated mobility tasks, such as driving a race car around a track. This method introduces the concept of control (cause and effect) to children and helps them learn that a joystick or switch can make something happen. However, this method does not take into account
  - the abnormal body movements that may occur once a child begins to move through space,
  - the child's ability to react appropriately to negative and perhaps dangerous situations,
  - the excitement of mobility, which can distract a child or cause an increase in tone (thus leading to other potential problems), and
  - the reinforcement gained through movement.
- Using a simulator approach, a child's own seating system or a simulated one is placed into a powered chair or base so that he or she is optimally seated.
  - A variety of control options are available – joystick, single switch for head, hand, and so forth. The child is allowed to use those controls previously determined to be appropriate. The joystick is the control of choice, as it provides the most direct, responsive control. It also is less costly and more reliable than most other control options. If joystick operation is not possible, a variety of custom-located switches will be tried. Finally, single-switch scanning can be considered. It is the most complex of the control options and requires the most cognitive skill and the most patience. Therefore, although single-switch scanning may be physically less complex for a child, other control options should be given priority.
  - The child is given time to learn how to operate the chair and to feel the effects of controlling mobility.
  - The child's ability to move the chair on command, to stop the chair on command, to follow directions, to maneuver through doorways, and so forth, is observed.
  - The child's ability to improve control with experience is monitored. (This does not necessarily take a long time; often, improvement can occur after only an hour of experience. Other times, a trial period might be appropriate.)
  - The child's motivation to master the skill is noted.

The family, clinician, and teacher help determine how much follow-up support is available for the training and supervision that is needed to ensure safe, successful operation of the powered technology.

At this point, there are several options:

- The child has shown sufficient proficiency to enable the technical team to proceed with a prescription.
- The child has shown considerable potential, but the team feels that further evaluation time or a trial period is necessary.
- The child has not performed sufficiently well and the team feels that further evaluation at this time is inappropriate. If powered mobility is still a goal, a program of prerequisite skill training could be established. Activities (prescribed by the physical or occupational therapist) might be directed towards the child's
  - learning to operate a switch,
  - learning directionality,
  - learning to follow commands, and
  - learning to avoid obstacles that may be dangerous, such as walls, steps, curbs, and so forth.

  Such activites might become a part of classroom routines or daily activities.

Device Selection

When selecting the mobility device, the team should try to accomplish the following:

- Match the functional needs of the child to the specifications of the mobility device. Both initial purchase price and maintenance costs must be considered at this time.
- Ensure access in multiple environments (e.g., home, school, community).
- Integrate other technology (e.g., the seating system, a manual mobility system, an augmentative communication device, an educational computer system). Most families need a manual chair as an option when transportation is not available for the powered device or when speed/facility is paramount.
- Be sure the system is reality-based. The following clues may indicate that the timing is not right to prescribe a mobility device:
  - The family is not ready to move their child into a mobility device or is not ready for this degree of independence on the part of their child.
  - The child is uninterested at this point.
  - Financial issues have become the total focus.
  - The family is already having difficulty providing maintenance for a less complex system.

  When such clues are present, the family and the evaluation team together need to make future plans. Compromises may need to be made. For example, if the family does not wish to transport a powered chair, then one should not be ordered. If funding is the major problem, the team should make referrals for outside support. See Appendix E for resources (available in many states) that can provide suggestions for funding options. If third-party payers will not purchase a chair, creative fund-raising might be considered. Some individuals have solicited churches, community-based businesses, charitable organizations, and so forth, and have brought in funds. One needs to be sure that there are documented results of a full mobility evaluation by a qualified team and sufficient justification for the specific equipment requested before looking for funding. Included in initial funding proposals should be allocations for maintenance costs.

We all need to realize that spending the money to acquire a device does not ensure that it will be used. Resources need to be used wisely to acquire technology for those who are ready to use it.

If the decision is made to select a mobility system, remember:

- First, choose the positioning system.
- Next, consider a manually propelled base that can be used as the primary base (it can be independently propelled by the child or by an attendant).
- If a powered base is indicated, then the type of base/chair and the control system must be chosen. Specifics of the choice, of course, are determined by the family in discussion with the technical team. A teacher's input is vital regarding the classroom and school environment, transportation, and the child's personal educational program as each relates to motor skills and mobility in particular. However, small classroom size or perceived bulkiness of a powered chair are not sufficient reasons to deny a child independence.

Child considerations integral to system selection are:

- **Age of the child** – The younger child requires a smaller chair and less complex controls (e.g., a joystick rather than a single switch). Further, younger children may need more training in safety and more supervision with powered devices.
- **Aesthetics** – Mobility devices should be appealing. The selection of the chair (i.e., its color and design) should be the child's choice. The child's seating system should be matched to the wheelchair of choice and, if a powered device has been selected, the controls mounted as unobtrusively as possible. For example, if the head is the center of control, the switches should be mounted to the back or side of the head or a simple headgear or light sensor should be mounted on the child's chosen headgear (e.g., headband, baseball cap).
- **Size/growth factors** – We know that children grow. Thus, whenever possible, a system that can grow with the child is ordered. The average life of a powered chair is 5 years and it should be able to accommodate 5 years of growth. Another factor that causes us to make careful allowances for growth is the fact that most funding agencies have a period of time designated during which they will not pay for a new chair. With self-propelled manual chairs, the width of the chair is critical to efficient rolling. Too large a chair may make it difficult for the child to reach the wheels. Size is not such a critical issue with powered

chairs in that creative mounting of controls and seating systems can allow for more flexibility. We need to remember, though, that a chair that is slightly too big will allow for more growth.

Finding/Building the Mobility Device

Families and appropriate team members should shop for a professional Rehabilitation Technology Supplier (RTS) who will provide maintenance and who has had experience with children having disabilities similar to their child's. (It may be that the RTS has already been identified and is a member of the child's team.)

Sometimes the question arises as to whether a mobility device should be purchased or made. Many professionals and family members believe that it is less expensive to make equipment than to buy it. However, the costs of materials, labor and turnaround time, the quality of craftsmanship, the potential legal risks, and the fact that commercially available equipment usually comes with a warranty all need to be carefully considered when weighing the merits of homemade equipment. These cautions are not intended to discredit the effectiveness of home-made devices that may be extremely helpful, especially for short-term applications. When thinking about whether to purchase or make a device, also consider the following points:

- Purchasing a piece of equipment can allow clinicians to use their time in training, program development, consultation, and direct treatment rather than in equipment fabrication.
- If a family moves, another manufacturer's representative is likely to carry the device and to be available to offer technical support.

If a device is to be made, one possible source of assistance is a private rehabilitation engineering firm. Close coordination with the child's team is essential to avoid the possibility that the device will be perfectly engineered but will not meet the functional needs of the child. Also, one of the technicians needs to commit to training and follow-up regarding use of the device. Another possible source is volunteer groups or engineering students. One must be cautious of the group's priorities and commitment to a schedule. Students often take a long time to design a product and are not available to service it when things go wrong. Also, they may design to the specifications of their professor, making the child's needs secondary. Volunteer groups also establish their own timetable and often, because they are not professionals in the field of assistive technology, design devices that already exist on the commercial market.

Sometimes the decision is made to purchase a commercially available device, but none exists that meets the child's need exactly, especially if the child's needs are complex. In such cases, it may be necessary to modify a commercially purchased device. When making modifications, particularly for wheelchairs or control systems, it is important to remember that modifications may invalidate the warranty. The child's family needs to carefully consider the ramifications and give their written permission for specified modifications.

Using the Mobility Device

When the child is ready to use the device, a number of factors come into play:

- **Motivation** – Unless there is a severe cognitive deficit, almost every child evaluated for mobility is highly motivated to succeed. The patterns of skill acquisition are sometimes unique and do not necessarily follow the clinician's or teacher's plan. Children often spend considerable time turning in circles before starting to follow straight lines. On rare occasions, the child is fearful of independent movement. Careful supervision of the first trials can alleviate this problem. One successful approach is to seat the child in the lap of the clinician or family member during mobility practice to help make the first experience with mobility pleasant and positive.

- **Independent/social factors** – Children need the opportunity to experience independence. They must be able to move toward and away from social situations as they desire and to perform tasks in the home that lead to independence (e.g., taking toys to their room, going to the kitchen for meals).

- **Self-image** – Being able to move allows for the development of an independent self-image, in that children can now do tasks by themselves instead of always relying on or waiting for others. They can determine for themselves the activities in which they wish to participate or those they just want to watch. One parent expressed the feeling that once her child had a mobility device, the umbilical cord had been cut for the first time.

  An aesthetically age-appropriate device can bring status to the child among peers that do and do not have disabilities. A new chair is appealing to all children. A mobility device enables these children to present themselves as capable rather than disabled.

- **Family education** – All care providers need to be educated before they are ready to accept mobility for a child. In addition to understanding the mechanics and maintenance of the technology (charging batteries for powered devices, keeping air in the tires), they must understand the issues of cognitive and personal growth. Some are very anxious and tend to push children before they have acquired the skills necessary to be independent. Others are reluctant to allow children to take the risks that lead to independence. All of these issues need to be addressed.

- **Home and school access** – The child's home is sometimes easy to modify with a ramp or a widened doorway, and federal laws require that school programs be accessible to children with disabilities.

- **Transportation** – Most powered chairs and scooters require the use of a van with federally approved tiedowns for transportation (Shaw, 1987). Not all scooters have an approved tiedown available on the commercial market. Those devices that are advertised as portable often require three to five assembly steps with several heavy components to be lifted into a car. Frequently, families and school personnel find this impractical.

- If the family owns a car and cannot obtain a van at this time, a chair that folds must be used; these are often less durable than the non-folding options.
- School transportation may be utilized for transporting the non-folding chair to school and back.
- Some children may require two mobility bases—a powered one for home and school and a manual one for the family to use in the community and on family outings. To save money and also because of the lighter weight, a number of families choose a stroller as the manual base even if the child can propel a manual chair over short distances. As the child grows, strollers become socially inappropriate, especially once the child becomes a teenager. Devices other than strollers should be considered to make transportation easier for the families while being aesthetically pleasing to the child.
- The community, which includes the child's immediate environment outside the home as well as locations in the community at large, must be accessible to the child. One needs to be sure that providing a child with a powered chair does not isolate the child from activities because of transportation or access difficulties.

Potential Roadblocks to Using the Device

- **Attitudes** – As a result of education, exposure to successful applications, and increased availability of technical support, resistance to mobility (especially powered mobility) is decreasing. People are beginning to accept the fact that efficient mobility complements other motor skills, and that a mobility device is not just another piece of equipment in an already cluttered environment. It also becomes clear that a mobility device can increase independence and the child's acquisition of cognitive and social skills.
- **Availability of recommended system components** – At one time, there were few chairs available for young children. This is changing as the market responds to a growing need. However, there is still need for a more comprehensive "wardrobe" of mobility devices, including scooters, bikes, chairs, carts, and so forth, that are fun in design and purpose. Members of the seating team have access to a great number of distributors and a variety of equipment, some of which is described in Appendix F (*Homecare*, 1991).

  There is also considerable concern about how people in wheelchairs are transported in school buses, private vans, and public transportation. Families and teachers are encouraged to review what is available in their area and to strongly recommend federally approved tiedown systems (Fields, 1991; Shaw, 1987). A vital source of information is the federal government's Architectural and Transportation Barriers Compliance Board which establishes federal guidelines and then disseminates information about them.
- **Repair cost/maintenance** – It has been estimated that the cost of maintaining or repairing a chair can amount to several hundred dollars a year over the life

of the chair. A frequent problem is that batteries must be replaced because of poor maintenance. To keep such costs to a minimum, families and the children themselves should be taught to follow a maintenance schedule.

Training for Mobility

Nonelectronic Preparation for Powered Mobility

Mobility includes movement through space. To help children experience dependent motion, they need to be swung, moved, and so forth, by family and school staff. In addition, there needs to be

- talk about directions and obstacles as children are carried (in any environment). Children need to experience falling or bumping into walls or doorways in a noninjurious way to realize that bumps do not necessarily cause serious injury. Some children are so terrified of bumping into a wall that they become very tense and, in fact, get into more difficulty;
- an opportunity for children to establish control over mobility at an early age by indicating where they want to go and then having adults respond to those wishes;
- access to small, commercially available mobility devices, when appropriate, such as tricycles and prone scooter toys, even if straps are needed or if the child needs assistance with the activity; and
- instruction in using controlled movement (i.e., clinicians should work on head control to encourage range without initiating abnormal asymmetrical tonic neck reflex [ATNR]). Such movements increase children's ability to move the head freely in rotation, allowing them to check for obstacles when driving. This prevents the ATNR from limiting motion or dictating patterns of movement.

Training for Powered Mobility

If a powered chair has been provided, a child should have a training period to become a safe and responsible driver. Some children only require lessons in basic safety and maintenance, while others may require months of supervised use. This is a very individual matter.

Using a powered mobility simulator, such as the one previously described under evaluation procedures, is one way to begin training even before the children receive their own equipment. It does not require them to transfer skills, but actually teaches skills in the same patterns they will use to operate their own systems.

Considerations for training for powered mobility include:

- **Coordination of technology goals** – Careful planning to coordinate the control motions and technology for all of a child's assistive devices is essential. For example, the positioning and mounting of an augmentative communication device should not preclude the positioning of the control for a powered chair or computer keyboard or a feeding device. Training the child to operate the control system of the powered mobility device must be compatible with and support the control of all technologies.

- **Training through activities that are fun** – We need to keep academics and drill work out of the training program, at least initially. The potential of the technology should be demonstrated to young children with activities that are fun and that they can master quickly. Refining the access methods, increasing the speed, and adding to the complexity of output systems can come later, once children have developed a positive attitude toward the equipment and what it can do for them. For now, we need to provide children with the opportunity to be in the chair and experience movement just for themselves and not for the approval of an adult.
- **Safety** – With young children or children with cognitive deficits, it is wise, during the training period or until a certain proficiency level is reached, to have a kill switch that can be operated by the trainer. Some children with severe physical disabilities may operate their own kill switch if they sense trouble or if the wheelchair controls are not operating properly.
- **Strategies to encourage independent mobility** – Teachers can encourage children to be responsible for getting to the lunchroom, bathroom, and so forth, by themselves. Families can do the same by planning family activities, such as walks, where the children can enjoy using their new freedom. Children's daily schedules can include maintenance checks of the battery, tires, and so forth, so that they learn to be responsible for the equipment. Recreation activities, such as a field day with wheelchair races and parades where wheelchair users are participants are very powerful and can be used to reinforce mobility. In general, children should be expected to use independent mobility in their work and play, just as all children do. Messages that the child receives will change from "Here, let me help you" to "You can manage that yourself." Independence in mobility facilitates an independent spirit and, ultimately, an independent person.

In addition to teaching the child how to operate the powered mobility, those working with the child must become familiar with some troubleshooting strategies in the event the system is not functioning properly on any given day. The adults must be able to check the following: (a) the batteries, to see if they are charged and well-maintained; (b) all the connectors, to make sure they are clean and firmly attached; and (c) connectors to the joystick (or other switches) to be sure they are firmly attached.

For additional information on mobility, refer to Appendix B, Resources for Positioning and Mobility.

Chapter VI Summary

The future is exciting for children with severe disabilities. There is and will be lots of technology. But, as we know, technology by itself is not the answer. Although teachers and families may not have all the skills needed to link children with these technological advances, support and assistance are available; there are caring people with clinical and technical expertise and there are funding sources. Our challenge is not an easy one, but the rewards are plentiful.

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Appendix A Assistive Technology Resource List

State Resources

Pursuant to federal legislation, the following states have been funded to develop consumer responsive, statewide, technology-related service delivery. For information about this project, contact

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Project Director
Department of Human Services
Division of Rehabilitation Services
Increasing Capabilities Access Network
2201 Brookwood Drive, Suite 117
Little Rock, AR 72202
(501) 666-8868
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FAX (501) 666-5319

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Bill West
State Coordinator for Assistive Technology
Rocky Mountain Resource and Training Institute (RMRTI)
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Arvada, CO 80004
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FAX (303) 420-8675

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Connecticut State Department of Human Resources
Bureau of Rehabilitation Services
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Hartford, CT 06105
(203) 566-3318

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University of Delaware
Center for Applied Science and Engineering
1600 Rockland Road
Wilmington, DE 19899
(302) 651-6834

Florida
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Department of Labor and Employment
Division of Vocational Rehabilitation
Bureau of Client Services
Rehabilitation Engineering Technology
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Tallahassee, FL 32399-0696
(904) 488-6210

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Georgia Department of Human Resources
Georgia Division of Rehabilitation Services
878 Peachtree Street, NE
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Atlanta, GA 30309
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(404) 894-7593

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HATS (Hawaii Assistive Technology System)
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Honolulu, HI 96813
(808) 521-8489

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University Center on Developmental Disabilities
Professional Building
129 W. Third Street
Moscow Latah, ID 83843
(208) 885-6849

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Illinois Assistive Technology Project
Department of Rehabilitation Services
Division of Planning and Special Initiatives
411 East Adams Street
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Indiana Department of Human Services
Office of Vocational Rehabilitation
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Iowa Program for Assistive Technology
University Hospital School
Iowa City, IA 52242
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FAX (319) 356-8284

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Kentucky Assistive Technology Service (KATS)
Network
KATS Network Coordinating Center
427 Versailles Road
Frankfort, KY 40601
(502) 564-4665
(800) 327-KATS
FAX (502) 564-3976

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Louisiana State Planning Council
on Developmental Disabilities
Department of Health and Hospitals
PO Box 3455
Baton Rouge, LA 70821-3455
(504) 342-6804

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Project Director
Division of Special Education
Maine Department of Education
State House Station #23
Augusta, ME 04330
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(207) 289-2550 (TDD)
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1 Market Center - Box 10
Baltimore, MD 21201
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New Jersey Department of Labor
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Commissioner Raymond L. Bramucci
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Madison, WI 53702
(608) 267-6720
(608) 266-9599 (TDD)

Organizations/Agencies*

Activating Children Through Technology (ACTT)
c/o Western Illinois University
27 Horrabin Hall
Macomb, IL 61455
(309) 298-1634

This university-based center supports a technology resource center that offers information dissemination, training, and evaluation services in microcomputer applications and related technology areas to individuals who are disabled.

Alliance for Technology Access
Apple Computer, Inc.
20525 Mariani Avenue, MS 43S
Cupertino, CA 95014
(415) 528-0747

The alliance was developed in association with the Disabled Children's Computer Group by Apple Computer's Office of Special Education Programs. This organization conducts research and provides information dissemination, database resources, referral services, and training related to the implementation of microcomputer technology with children and adults who are disabled. The alliance currently is developing model assistive technology sites across the United States.

American Occupational Therapy Association (AOTA)
1383 Piccard Drive
PO Box 1725
Rockville, MD 20850-0822
(301) 948-9626

American Physical Therapy Association (APTA)
1111 N. Fairfax
Alexandria, VA 22314
(703) 684-2782

American Speech-Language-Hearing Association (ASHA)
10801 Rockville Pike
Rockville, MD 20852-3279
(800) 638-6868 (members) (voice or TDD)
(800) 638-8255 (consumers) (voice or TDD)

* This listing was compiled by the American Speech-Language-Hearing Association (ASHA). It does not attempt to be all-inclusive nor does it imply ASHA endorsement.

Apple Computer, Office of Special Education
20525 Mariani Avenue, MS 43S
Cupertino, CA 95014
(408) 974-8601

Through this office, Apple Computer works with rehabilitation, education and advocacy organizations nationwide to identify computer-related needs of individuals who are disabled and to assist in the development of responsive programs. Apple maintains a database of hardware, software, publications, and organizations involved in the use of assistive technology.

Association for Retarded Citizens (ARC)
ARC National Headquarters
500 E. Border
Suite 300
Arlington, TX 76010
(817) 261-6003
(817) 277-0553 (TDD)

ARC is the nation's largest volunteer organization solely devoted to improving the lives of all children and adults with mental retardation and their families. The association also fosters research and education regarding the prevention of mental retardation in infants and young children.

Blissymbolics Communication International
250 Ferrand Drive, Lower Concourse
Don Mills, Ontario M3C 3P2 Canada
(416) 421-8377

This organization is dedicated to the development and dissemination of Blissymbolics as a communication system for people who do not speak.

Carolina Literacy Center
Department of Medical Allied Health Professions
Campus Box #8135
University of North Carolina at Chapel Hill
Chapel Hill, NC 27599-8135
(919) 966-7486

In addition to other services, this center strives to meet the needs of people with severe speech and physical impairments through literacy symposiums/workshops and to make available publications on the topic of literacy.

Closing the Gap, Inc.
PO Box 68
Henderson, MN 56044
(612) 248-3294

This organization offers regional and national conferences, workshops, and training. CTG also publishes a newspaper dedicated to the application of assistive technology with individuals who are disabled.

Committee on Personal Computers and the Handicapped (COPH-2)
PO Box 7701
Chicago, IL 60680-7701
(708) 866-8195

This consumer organization disseminates information, provides technical consultations, and sells adaptive computer devices. The organization also publishes information resources and supports an electronic bulletin board.

Hear Our Voices
105 W. Pine Street
Wooster, OH 44691
(216) 262-4681

A national patient advocacy group run by Prentke Romich Company. Any augmentative communication aid user or family member can join this organization.

IBM National Support Center for Persons with Disabilities (IBM-NSCPD)
PO Box 2150
Atlanta, GA 30055
(800) 426-2133

This IBM support center provides information, referral, advocacy, and demonstration center services. The center provides specific IBM computer applications and resources for individuals who are disabled.

International Society for Augmentative and Alternative Communication (ISAAC)

United States Society for Augmentative and Alternative Communication (USSAAC)
PO Box 1762, Station R
Toronto, Ontario M4G 4A3 Canada
(416) 737-9308

The purpose of these organizations is to facilitate the international and national advancement of the transdisciplinary field of augmentative and alternative communication.

National Federation for the Blind
1800 Johnson Street
Baltimore, MD 21230
(301) 659-9314

A national organization with more than 500 state and local chapters. The organization provides information dissemination, advocacy, referral services, database, and resource support services to persons who are visually impaired.

National Lekotek Center
CompuPlay
711 E. Colfax
South Bend, IN 46617
(219) 233-4366

CompuPlay provides computer play sessions for family members and children with special needs ages 2 to 14. Adaptive equipment and software are employed to allow children to play and learn. The organization provides a software lending library and computer demonstration center.

RESNA – Association for the Advancement of Rehabilitation Technology
1101 Connecticut Avenue, NW, Suite 700
Washington, DC 20036
(202) 857-1199

RESNA plans and conducts scientific, technical, and educational meetings and programs; serves as a forum for the development of standards, terminology, and guidelines; and provides consultation and coordination concerning matters of interest to RESNA members. It also publishes and disseminates information on technology and service delivery.

TASH – The Association for Persons with Severe Handicaps
11201 Greenwood Avenue North
Seattle, WA 98133
(206) 361-8870

The purpose of TASH is to create a community where no one is segregated and everyone belongs. TASH is dedicated to research, education, dissemination of knowledge and information, legislation, litigation, and excellent services.

Technology and Media Division (TAM)
Council for Exceptional Children
1920 Association Drive
Reston, VA 22091-1589
(703) 620-3660

This division of the Council for Exceptional Children keeps abreast of advances in special education technology. The organization provides information dissemination and referral services and offers several publications on the use of technology.

Trace Research and Development Center
1500 Highland Avenue, S-151 Waisman Center
Madison, WI 53705
(608) 262-6966
(608) 263-5408 (TDD)

The Trace Center develops and disseminates information related to nonvocal communication, computer access, and technology to aid individuals who are disabled. The center also conducts research and training in technology.

UCLA Intervention Program for Handicapped Children
1000 Veteran Avenue, Room 23-10
Los Angeles, CA 90024
(213) 825-4821

This university-based technology program has developed software for use with individuals who are disabled. The program also supports a resource center and is actively involved in technology training activities.

Periodicals*

Accent on Living
Published by
Cheever Publishing
PO Box 700
Bloomington, IL 61701

American Journal of Audiology: A Journal of Clinical Practice
Published by the
American Speech-Language-Hearing Association (ASHA)
10801 Rockville Pike
Rockville, MD 20852-3279
(301) 897-5700 (voice or TDD)

American Journal of Speech-Language Pathology: A Journal of Clinical Practice
Published by the
American Speech-Language-Hearing Association (ASHA)
10801 Rockville Pike
Rockville, MD 20852-3279
(301) 897-5700 (voice or TDD)

American Occupational Therapy Journal
Published by the
American Occupational Therapy Association
1383 Piccard Drive
Rockville, MD 20850-0822
(301) 948-9626

Assistive Device News
Newsletter published by
Central Pennsylvania Special Education Regional Resource Center
150 S. Progress Avenue
Harrisburg, PA 17109
(717) 657-5840

Assistive Technology
Published by
Demos Publications
156 Fifth Avenue, Suite 1018
New York, NY 10010
(212) 857-1199

Assistive Technology Quarterly
Published by
RESNA Press
1101 Connecticut Avenue NW, Suite 700
Washington, DC 20036
(202) 857-1140

Augmentative and Alternative Communication (AAC)
Sponsored by the
International Society for Augmentative and Alternative Communication (ISAAC)
Published by
Decker Periodicals Publishing, Inc.
PO Box 620, Station A
Hamilton, Ontario L8N 3K7 Canada
(416) 522-7017

Augmentative Communication News
Published by
Augmentative Communication, Inc.
One Surf Way, Suite #215
Monterey, CA 93940
(408) 649-3050

Closing the Gap
Newspaper
Address correspondence to:
Closing the Gap
PO Box 68
Henderson, MN 56044
(612) 248-3294

Communication Outlook
An Affiliate of ISAAC.
Published by
Communication Outlook
Artificial Language Laboratory
Michigan State University
405 Computer Center
East Lansing, MI 48824-1042
(517) 358-0870

Communicating Together
An affiliate of ISAAC.
Published by
Sharing to Learn
PO Box 986
Thornhill, Ontario L3T 4A5 Canada

Computer-Disability News
Published by
National Easter Seal Society
5120 S. Hyde Park Blvd.
Chicago, IL 60615
(312) 667-8400

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Computer Teacher (The)
Published by
International Society for Technology in Education
1787 Agate Street
Eugene, OR 97403-1923
(503) 346-4414

Educational Technology
Published by
Educational Technology
720 Palisade Avenue
Englewood Cliffs, NJ 07632
(201) 871-4007

Exceptional Parent
Published by
Boston University, School of Education
605 Commonwealth Avenue
Boston, MA 02215

Journal of Applied Behavior Analysis (JABA)
Published by the
Society for the Experimental Analysis of Behavior, Inc.
Address correspondence to
Business Manager, Mary Louise Wright
Department of Human Development
University of Kansas
Lawrence, KS 66045

Journal of Speech and Hearing Research (JSHR)
Published by the
American Speech-Language-Hearing Association (ASHA)
10801 Rockville Pike
Rockville, MD 20852-3279
(301) 897-5700 (voice or TDD)

The Journal of the Association for Persons with Severe Handicaps (JASH)
Published by the
Association for Persons with Severe Handicaps (TASH)
7010 Roosevelt Way, NE
Seattle, WA 98115

Language, Speech, and Hearing Services in Schools (LSHSS)
Published by the
American Speech-Language-Hearing Association (ASHA)
10801 Rockville Pike
Rockville, MD 20852-3279
(301) 897-5700 (voice or TDD)

Physical Therapy
Published by the
American Physical Therapy Association
1111 N. Fairfax
Alexandria, VA 22314
(703) 684-2782

Research in Developmental Disabilities
Published by
Pergamon Press, Inc.
Maxwell House
Fairview Par
Elmsford, NY 10523
or
Pergamon Press plc
Headington Hill Hall
Oxford OX3 0BW, England

Team Rehab Report
Published by
Miramar Publishing Company
6133 Bristol BHW
PO Box 3640
Culver City, CA 90231-3640
(213) 337-9717
(800) 543-4116

Technology and Disability
Published by
Andover Medical Publishers, Inc.
80 Montvale Avenue
Stoneham, MA 02180
(800) 366-2665

Topics in Language Disorders
Published by
Aspen Publishers, Inc.
7201 McKinney Circle
Frederick, MD 21701
(800) 638-8437

TRACES Newsletter
Published by
Teaching Research Division
Western Oregon State College
345 N. Monmouth Avenue
Monmouth, OR 97361
(503) 838-8778

VOICES
Newsletter published by
Hear Our Voices
105 West Pine Street
Wooster, OH 44691
(216) 262-4681

Funding Resources*

Assistive technology: A funding workbook (1991)
By: Morris, M., & Golinker, L.
RESNA Technical Assistance Project
1101 Connecticut Avenue, NW, Suite 700
Washington, DC 20036
(202) 857-1140

Part I of this workbook is a road map to funding sources, and Part II is an outline of federal laws and rules.

Funding excuses (1991)
By: Golinker, L.
United Cerebral Palsy Associations
1522 K Street,
Suite 1112
Washington, DC 20005
(800) 872-5827

This free memorandum lists 17 common "excuses" offered by four funding programs to deny requests for augmentative and/or alternative communication devices and services in particular, and many other types of assistive technology in general. The four funding programs are Medicaid, special education, vocational rehabilitation, and private insurance. A response is provided for each excuse. The intent is to help in preparing initial applications so that funding will be approved and to provide a strategy for appealing an initial funding denial.

Assistive technology and the Individualized Education Program (1992)
By: RESNA Technical Assistance Project
RESNA Technical Assistance Project
1101 Connecticut Avenue NW, Suite 700
Washington, DC 20036
(202) 857-1140

This product provides information on how to incorporate assistive technology into an IEP for children and youth with disabilities.

Handbook of assistive technology (1992)
By: Church, G., & Glennon, S. (Eds.)
Singular Publishing Co.
4284 41st Street
San Diego, CA 92105-1197
(619) 521-8000

The many faces of funding (1986)
By: Hofman, A.
Phonic Ear, Inc.
250 Camino Alto
Mill Valley, CA 94941
(415) 383-4000

This textbook focuses on funding strategies for communication devices. The information it gives is also applicable to funding for other types of assistive technology aids. It highlights sources of funding on the federal, state, local, educational, and private levels.

Medicaid coverage of AAC (available late fall 1992)
By: Golinker, L.
United Cerebral Palsy Associations
1522 K Street, Suite 1112
Washington, DC 20005
(800) 872-5827

This free set of materials explains Medicaid coverage of augmentative and alternative communication through Early Periodic Screening, Diagnostic, and Treatment Services (EPSDT); existing state policies regarding AAC coverage; and model complaints to gain AAC coverage through Medicaid/EPSDT. The materials will be distributed to UCPA affiliates, state Protection and Advocacy Groups, federally funded state Assistive Technology Centers, and state Developmental Disabilities Planning Councils. They may also be obtained by calling UCPA at the number listed above.

Summary of Existing Legislation Affecting Persons with Disabilities (1992)
By: Department of Education
Clearinghouse on Disability Information
U.S. Department of Education
Room 3132 Switzer Building
Washington, DC 20202-2524
(202) 732-1241 (voice or TDD)
(202) 732-1723 (voice or TDD)

This booklet describes many federal laws and programs that affect people with disabilities.

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Databases*

Database resources are large clearinghouses for information on a wide variety of assistive technology, including new and existing hardware, software, and related resources. These databases provide information via on-line electronic networks, floppy disks, CD-ROM, audiocassettes or printed material.

ABLEDATA—Database of Assistive Technology Information
National Rehabilitation Information Center (NARIC)
(operated by Macro International Inc.)
Silver Spring Centre
8455 Colesville Road, Suite 935
Silver Spring, MD 20910
(800) 346-2742
(301) 588-9284

ABLEDATA is an extensive database that contains listings of assistive technology available both commercially and non-commercially from domestic and international manufacturers and distributors. It is an information system that enables people with disabilities and their families to identify and locate devices that will assist them at home, work, school, and in the community; it also serves as a resource for practitioners, researchers, engineers, and advocates in the rehabilitation field.

Some of the areas that can be searched in the database are mobility, seating, communication, and environmental controls. Database citations provide product brand name and generic name, manufacturer name and address, price, and a detailed description of the product. Search results are available in regular print, enlarged print, Braille, audio cassettes, diskettes, CD-ROM, and in Spanish. The ABLEDATA classified service is also available for buying or selling used assistive devices or equipment.

Accent on Information
PO Box 700
Bloomington, IL 61702
(309) 378-2961

A computerized database of product, publication, and related resource information on how to adapt assistive technology equipment. The database contains over 6,000 product entries.

Access/Abilities
PO Box 458
Mill Valley, CA 94942
(415) 388-3250

A database of technology resources for individuals who are physically disabled. The database contains information on services, hardware, and software aids.

Assistive Device Database System
Assistive Device Center
California State University
Sacramento, CA 95819
(916) 278-6422

This database contains information on assistive devices and related resource listings. It focuses on the educational implications of using assistive technology with disabled populations.

Adaptive Device Locator System
Academic Software, Inc.
331 West Second Street
Lexington, KY 40507
(606) 233-2332

This floppy-disk-based system provides descriptions and pictures of assistive devices and lists of sources for products and product information. The system can generate mailing labels and form letters to vendors. The database includes over 600 generic device descriptions, categorized by over 350 functional goal descriptions and cross-indexed with over 300 vendors.

Compuserve
5000 Arlington Centre Blvd.
PO Box 20212
Columbus, OH 43220
(614) 457-8600

The system contains a users' database that contains information on all aspects of technology used by individuals who are disabled.

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DEAFNET
508 Bremer Bldg., 7th and Roberts Streets
St. Paul, MN 55101
(612) 223-5130

DEAFNET is a nonprofit organization that serves technology users who are hearing impaired. It has a nationwide electronic mail service with international links.

ECER
Council for Exceptional Children
1920 Association Drive
Reston, VA 22091-1589
(703) 620-3660

ECER is the ERIC database for technology users who are disabled. The database contains bibliographic information on books, articles, teaching materials, and reports on the education of individuals who are disabled.

Handicapped Education Exchange (HEX)
11523 Charlton Drive
Silver Spring, MD 20902
(301) 681-7372

The HEX database of' s resource information on the use of technology with individuals who are disabled. The database contains information on products, organizations, and related information on training and service.

HYPER-ABLEDATA-PLUS
Trace Center Reprint Service
1500 Highland Avenue, S-151 Waisman Center
Madison, WI 53706
(608) 263-6966

The CD-ROM version of the on-line version of ABLEDATA. This disk provides information on over 16,000 assistive technology products. The system also provides pictures and sound samples of many database items, and it has an access system for users who are blind or visually impaired.

National Technology Center
American Foundation for the Blind, Inc.
15 W. 16th Street
New York, NY 10011
(212) 620-2000

The center maintains three database systems: National Technology Database, Evaluations Database, and Research and Development Database. Each database focuses on resources for individuals who are blind or visually impaired and professionals who work with them.

Solutions
Apple Computer, Inc.
20525 Mariani Avenue, MS 43S
Cupertino, CA 95014
(408) 973-2732

The database contains information on hardware, software, organizations, and publications maintained by Apple Office of Special Education Programs. The database can be accessed via SpecialNet or AppleLink.

SpecialNet
2021 K Street, NW, Suite 215
Washington, DC 2006
(202) 835-7300

The largest computer network in the United States devoted exclusively to the information needs of professionals in special education.

Appendix B Resources for Positioning and Mobility

Manufacturers/Vendors*

Adaptive Engineering Lab
2A-3, 4403 Russel Road
Lynnwood, WA 98037
(800) 327-6080

Danmar Products IAC
221 Jackson Industrial Drive
Ann Arbor, MI 48103
(313) 761-1990

Enduro by Wheel Ring, Inc.
199 Forest Street
Manchester, CT 06040
(714) 779-6300

ETAC USA
2325 Parklawn Drive, St. P
Waukesha, WI 53186
(414) 796-4600

Freedom Designs, Inc.
310 E. Easy Street
Simi Valley, CA 93065
(805) 582-0077

Gunnell, Inc.
8440 State Street
Millington, MI 48746
(517) 871-4529

INVACARE – AVANTI
899 Cleveland Street
PO Box 4028
Elyria, OH 44036
(216) 329-6133

J.A. Preston Co.
60 Page Road
Clifton, NJ 07012
(201) 777-2700

Jay Medical Ltd.
PO Box 18656
Boulder, CO 80308
(800) 648-8282

LDC Corporation of America, Inc.
20 Independence Court
Folcroft, PA 19032
(808) 782-6324

Metalcraft Industries, Inc.
399 N. Burr Oak Avenue
Oregon, WA 53575
(608) 835-3233

Mulholland Positioning Systems, Inc.
215 N. 12th Street
PO Box 391
Santa Paula, CA 93060
(805) 525-7165

Ortho-Kinetics
Box 1647, W 220
N. 507 Springdale Road
Waukesha, WI 53187
(800) 558-7786

Otto Bock Industries, Inc.
3000 Xenium Lane N.
Minneapolis, MN 55441
(612) 553-9464

Pin Dot Products
6001 Gross Point Road
Niles, IL 60714
(312) 774-1700

Pyramid Rehabilitation
4993 Southern
Memphis, TN 38117
(800) 962-7615

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R. J. Cooper & Assoc.
Adaptive Technology Specialists
24843 Del Prado # 283
Dana Point, CA 92629

Rolto, Inc.
100 Florida Avenue
Belleville, IL 62221
(800) 851-3449

Snug Seat, Inc.
PO Box 1141
Matthews, NC 28106
(704) 847-0772

Special Health Systems
225 Industrial Parkway S.
Aurora, Ontario, L4G 3U5 Canada
(416) 841-1032

Sunrise Medical/Quichie Designs
2842 Business Park Avenue
Fresno, CA 93727-1328
(209) 292-2171

For additional information about wheelchairs, see Appendix F.

Print Resources

Barker, M., & Cook, A. (1984). A systematic approach to evaluation of physical ability for control of assistive devices. *Proceedings of the Second International RESNA Conference on Rehabilitation Engineering.* RESNA, 1101 Connecticut Ave., NW, Suite 700, Washington, DC 20036.

Bergen, A. F. (1991). *Positioning the client with central nervous system deficits: The wheelchair and other adapted equipment, 3rd edition.* Valhalla Rehabilitation Publication, Ltd., PO Box 195, Valhalla, NY 19595.

Jaffee, K. (Ed.) (1987). Childhood powered mobility: Developmental, technical, and clinical perspectives. *Proceedings, First NW Regional RESNA Conference 1987.* RESNA, 1101 Connecticut Ave., NW, Suite 700, Washington, DC 20036.

Norgaard, M. (1987, September). Riding on power. *Rx Home Care,* 51–53.

Proceedings of the Fourth and Sixth International Seating Symposiums. University of British Columbia, Continuing Education in the Health Sciences, 105-2194 Health Sciences Mall, Vancouver, BC Canada U6T 1W5.

Proceedings of the Fifth and Seventh International Seating Symposiums. University of Tennessee, 682 Court Ave., Memphis, TN 38163.

The Fortress Scientific Institute. (1986). *Clinical series on mobility.* Buffalo, NY: PEGASUS.

Trefler, E., Hobson, D., Shaw, C., Taylor, S., & Monahan, L. (in press). Seating for persons with physical disabilities. *Pro Review.* Therapy Skill Builders, 3830 E. Bellevue, PO Box 42050, Tucson, AZ 85733.

Verburg, G., Snell, E., Pilkington, M., & Milner, M. (1984). Effects of powered mobility on young handicapped children and their families. *Proceedings of the Second International Conference on Rehabilitation Engineering.* RESNA, 1101 Connecticut Ave., NW, Suite 700, Washington, DC 20036.

Ward, D. (1984). *Positioning the handicapped child for function: Guide to evaluate and prescribe equipment for the child with central nervous system dysfunction* (2nd ed.). Chicago: Phoenix Press.

Appendix C Resources for Access

Manufacturers/Vendors*

Adaptive Communication Systems, Inc.
Box 12440
Pittsburgh, PA 15231
(800) 247-3433

Crestwood Co.
6625 N. Sidney Place
Milwaukee, WI 53209
(414) 352-5678

Don Johnston Developmental Equipment, Inc.
PO Box 639
Wauconda, IL 60084
(800) 999-4660

Mayer-Johnson Co.
PO Box AD
Solana Beach, CA 92075-0838
(610) 481-2489

Prentke Romich Co.
1022 Heyl Road
Wooster, OH 44691
(800) 642-8255

TASH (Technical Aids and Systems for the Handicapped), Inc.
91 Station Street
Ajax, Ontario L1S 3H2 Canada
(416) 686-4129

Toys for Special Children
385 Warburton Avenue
Hastings-on-Hudson, NY 10706
(914) 478-0960

Words+
PO Box 1229
Lancaster, CA 93584
(800) 869-8521

Zygo Industries, Inc.
PO Box 1008
Portland, OR 97207-0838
(800) 234-6006

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Print Resources

Bradenburg, S., & Vanderheiden, G. (Eds.) (1987). *Communication, control, and computer access for disabled and elderly individuals. Resource Book 2, Switches and environmental controls.* Boston: College Hill Press.

Burkhart, L. (1980). *Homemade battery powered toys and educational devices for severely handicapped children.* Linda Burkhart, 6201 Candle Court, Eldersburg, MD 21784, (410) 795-4561.

Goossens', C., & Crain, C. (1992). *Utilizing switch interfaces with children who are severely physically challenged.* Zygo Industries, Inc., PO Box 1008, Portland, OR 97207-1008, (800) 234-6006.

Lee, K., & Thomas, D. (1990). *Control of computer-based technology for people with physical disabilities. An assessment manual.* Toronto: University of Toronto Press.

Wright, C., & Nomura, M. *From toys to computers: Access for the physically disabled.* Don Johnston Developmental Equipment, Inc., PO Box 639, Wauconda, IL 60084, (800) 999-4660.

Appendix D Case Study

The following is a case study described by Lee and Thomas (1990)[1] that illustrates a flow for the assessment and provision of technology used to access technical devices.

Stage 1: Gather Background Information

Upon review of the completed Background Information Questionnaire, the referring therapist was interviewed and the Interview Forms were completed. Gerry is a bright, active, nine-year-old boy who is determined to be as independent as possible. He has cerebral palsy with athetoid movements and is seated in a custom moulded orthotic seating system within a manual wheelchair.

Gerry is able to sit on a wooden child's arm-chair with pommel. He attends a school for children with physical disabilities and receives occupational therapy, physiotherapy, special education, music therapy, and augmentative communication services. Gerry is able to feed and dress himself with assistance. He is non-speaking and communicates by pointing to Blissymbols and traditional orthography sight words on a manual graphic display.

Gerry is very interested in being independent in social situations (e.g., communicating through the use of his display, limited speech, facial expressions, natural gestures, and voice output communication device), in school work (e.g., using a computer to independently complete worksheet activities), and in mobility (e.g., driving a powered wheelchair indoors and outdoors, and participating in wheelchair sports). Gerry has excellent facilitators who are keen on encouraging his independence, and supporting his technology and personal growth needs. Two months previous to this assessment, Gerry had surgery (i.e., hamstring releases) which markedly improved his stability, seating, and fine motor function.

Since Gerry was being considered for discharge from his present school and for subsequent placement within an integrated community school, the comprehensive assessment team working with Gerry were investigating the appropriate non-technical approaches and technology which would foster Gerry's independence. His customized contoured seating

[1] Lee, K., & Thomas, D. (1990). *Control of computer-based technology for people with physical disabilities. An assessment manual.* Toronto: University of Toronto Press. Special thanks to the University of Toronto Press for permission to reproduce this case study.

system and tray and a small graphic communication display including traditional orthography, pictographic, and symbolic systems were being modified. In addition, he was referred to the Access Team for control of:

- A new power wheelchair
- A stationary computer for home use (i.e., a duplicate of the system used in the classroom) which could be used for written communication, language development and academic work
- A portable voice output communication aid (VOCA) to allow communication of routine and novel utterances with familiar and non-familiar listeners, both readers and non-readers.

Past experience with technology

Gerry had successfully driven an antiquated powered wheelchair, by activating 5 capacitive touchplates with both hands. This is a direct selection access system in which each of the four touchplates represents a direction and the fifth touchplate represents on/off. This wheelchair was on loan from the school. His driving, despite the limitations imposed by the old system, was safe and reliable and he had mastered functional competence in driving indoors.

Gerry had also used an enlarged membrane keyboard to access the school's personal computer for written communication and academic work. This keyboard had one hundred and twenty-eight 1" x 1" squares which could be programmed to send whole words, phrases, function commands, and punctuation. Gerry's selection set consisted of symbols and traditional orthography. When a keyguard was used, Gerry was successful in directly contacting the desired squares with the fingers of his left hand. However, he exhibited much overflow and attempted to posturally compensate for his instability and athetosis by leaning on the side of the chair, tray, or table, and by gripping the edge of the keyboard on the tray. Gerry was able to perform all the set-up preparations with the exception of turning the computer on, as the switch was out of reach, and placing 5 1/4" floppy disks in the drive.

Gerry has also had trials of two large and unwieldy VOCAs with keyboards similar to the one used on the computer. Although he understood how to use VOCAs, he was less successful with these keyboards as no keyguards were available for them. In addition, each keyboard would occupy

Gerry's entire wheelchair tray, leaving no room to mount the touchplates for driving the powered wheelchair.

Features Analysis of Gerry's needs and criteria for the potential access systems which could be prescribed decided which of the following features were important to consider. See Features of Total Access System form.

Affordability No concern.

Attractiveness The access systems would be most acceptable if they were not too overwhelming or technical in appearance (i.e., less chrome, more racing stripes and children's colours), and not too large, making Gerry look dwarfed. The systems should not look too technical (i.e., for VOCA, inconspicuous; for computer, something you might expect to see in a living-room).

Circumstance adaptability Access systems should be able to accommodate Gerry's communication needs, and have the potential to support the use of symbols and whole words. They should permit the use of traditional orthography and facilitate direct access to a standard keyboard (i.e., detachable keyboard) in the future.

Environmental flexibility It would be ideal if the access systems could be used with the desired target systems at home, school, and for recreation.

Intersystem compatibility If possible, the proposed access systems should work with all the desired target systems (at least not impede the use of a different target system). It would be ideal if Gerry could also use the access systems to control an environmental control unit at home.

Manageability The main goal is Gerry's independence and self-reliance. The systems will be used by new facilitators who may/may not have experience and the family which has little experience but is willing to learn.

Mounting flexibility It should be easy to move and mount the access systems in the wheelchair and on the floor.

Portability Access systems should complement the target system's portability (i.e., ensuring that Gerry can use the VOCA on the floor, a table, and his wheelchair). The computer access system should be compact and easy to store.

System durability Gerry is an active young boy who enjoys participation and sports, but also exhibits poor coordination. Therefore, systems should be able to tolerate much wear and tear.

Assessment considerations Analysis of Gerry's needs and criteria for the assessment equipment, environment, and approach reveals factors which the Team can use to structure a more workable, potentially successful assessment. See Assessment Considerations form.

Equipment Indications are that all trial devices should be compact, transportable and allow maximal independence. Communication skills indicate the type of selection set to be used for Gerry, and potential computer/VOCA applications for trials. Gerry should be evaluated to see if he can deal with whole word versus letter by letter presentation to determine potential for predictive linguistics/word completion.

Approach The report of Gerry's motor skills indicates that the Team should carefully examine his control acts to increase stability and to decrease overflow and unintentional movement.

Environment Information from the questionnaire indicates that all facilitators are interested and supportive. Training and support are being requested by the family and may be required by the staff in the new school. Assessment sessions may require a large room to accommodate several facilitators.

Indications are that Gerry is safe driving indoors. However, he may need instruction/supervision out-of-doors and in narrow, confined spaces.

Stage 2: Observation

Gerry was observed during a typical morning in his classroom setting during "News Time." Gerry exhibited low truncal tone and a tendency to fix at his shoulders and hands. He often draped his body over available support surfaces (i.e., table, tray, armrests, laterals) to increase his stability. He had no evidence of primitive reflexes. However, he did exhibit overflow and tended to show initial mirroring of actions performed by his left upper extremity on his right side.

Gerry was observed driving the old wheelchair with the 5 touchplates in an operationally competent and functional manner. He was safe and careful. His control acts were precise and exact. However, the access system was temperamental. Observation of his ability to scribble with a crayon during creative arts sessions prompted the question of possible joystick control.

Gerry was observed using an enlarged (20" x 10") 128 key membrane keyboard with keyguard. He used his left hand to quickly and accurately access the 1" keys closer to his body and in the bottom left quadrant. Overflow was exaggerated when Gerry had to reach the edge of the keyboard, as he extended his elbows and directed the movement from his shoulder without any upper extremity stabilization. He attempted to use his right hand to access keys in the top right quadrant. When indicating choices on his graphic display or in a school workbook, Gerry was able to point to items smaller than 1/2" and in closer proximity than was available on the membrane keyboard.

Stage 3: Direct Selection Survey

From the background information and observations of Gerry it was evident that he had good enough function in the upper limbs to continue with direct selection techniques. Targeting was assessed with both left and right limbs. Function was much better with his left upper limb as indicated by the high ratings in Accuracy and Ease, and a medium rating in the Quality of movement.

He had no difficulty in isolating finger movement in the left hand space, but did with the right hand. Although Gerry was able to use his left index finger and/or thumb to access 1/2" squares on his 24" x 26" tray, his ideal work area appeared to be closer to the middle of this area (i.e., 12" x 15" area slightly offset to the left). The optimum orientation of the work area was a horizontal surface parallel to the floor and positioned at his elbow level. While accessing this area, it was necessary for Gerry to be seated in his custom chair which provided lateral support and to stabilize himself by holding onto the edge of his tray with his right hand.

See Direct Selection Survey form. In consideration of his good skills in direct selection, this technique was investigated further.

Stage 4: Keyboard Investigation (Communication and Computer)

Using the information derived from the Survey, a suitable input device was simulated for use with Gerry's control act to determine the characteristics of the other access system components. The input device was in fact part of a VOCA which has 1/2" keys spaced 1/8" apart in a rectangular keyboard arrangement approximately 12" x 15" in size. It was placed flat in the centre of Gerry's tray. See Keyboard Investigation form.

Optimizing Gerry's control

Verification of the control act

Gerry tended to stabilize his left hand by grasping the far left edge of the top of the keyboard, while his right hand grasped the edge of the tray. He was able to isolate his left index finger or thumb and directly contact a desired key 90% of the time. When he let go of the keyboard with his left hand, he had no difficulty activating all 128 available keys with a minimal number of errors, mis-hits, double hits or motor planning difficulties.

Refinement of the input device characteristics

Access was evaluated by comparing the timing and contact with specific targets on the enlarged keyboard (1" square membrane keys) with targets on the smaller VOCA keyboard (1/2" square keys). Gerry's timing was faster on the smaller keyboard. He was more accurate and his overflow was decreased significantly. Thus, his control act was enhanced when he worked within the smaller range and spontaneously stabilized himself on the keyboard and tray edges. The "beep" which accompanied each key activation provided good auditory feedback to Gerry regarding his control. A conventional keyguard was provided to reduce accidental mis-hits. However, other control act minimization or amplification techniques were not required.

Definition of selection set characteristics

To decrease the cognitive load of learning a new selection set, the vocabulary, the presentation, and organization of selectable items were duplicated from Gerry's manual communication display. Commonly used and familiar vocabulary items were positioned in the top two-thirds of the selection set display / keyboard area where he accesses more easily. Letters were placed in alphabetical order (more familiar to Gerry) in the lower one-third along with some commonly used functions. Gerry stabilizes his left hand on the bottom edge of the keyboard when accessing these keys. Thus accuracy and speed are optimized.

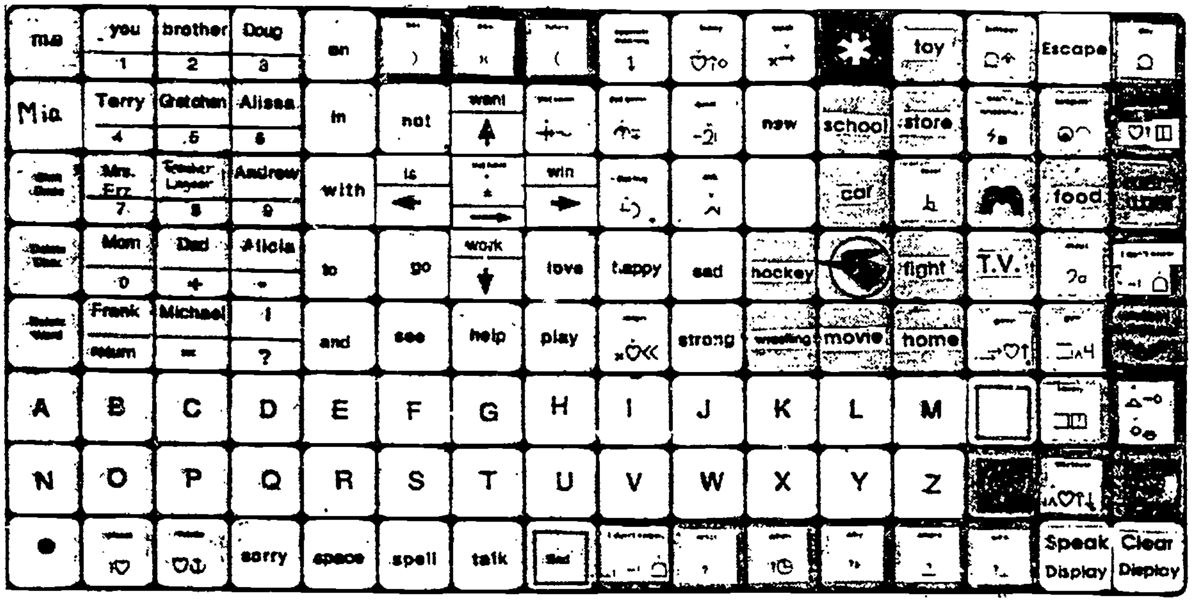

Figure 16: VOCA selection set display

Maximizing Gerry's input

Thus far, certain access system characteristics have been specified in order to take advantage of Gerry's control. Next, techniques to maximize his input or increase his rate of communication were explored. One technique was to colour code groups of related selectable items to assist Gerry in quickly locating desired items. "People" items were yellow; "action" items were green/blue; "object" items were peach; "functions" and "question" items were pink; and "alphanumerics" and "prepositions" were white.

A second technique was to encode Gerry's commonly used phrases such that a minimal number of key activations would result in a message which normally requires many keystrokes. For example, Gerry's pet phrases included "Edmonton Oilers, hurrah!" and "Do you want to hear a joke?" To effect each phrase, Gerry hits the "magic key," then the key containing the phrase. A menu of the phrases and their codes was attached to the VOCA.

Application information characteristics

The information provided by the application (i.e., VOCA, in the form of a visual display and spoken output) also provided additional feedback which promoted Gerry's physical control of the access system.

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Stage 3: Powered Mobility Joystick Survey

Information gained from previous stages indicated that Gerry had the potential and was very motivated to use a joystick. His control, however, was not initially sufficient to use a proportional joystick. In the Survey stage Gerry's grasp was examined to determine the appropriate type of joystick knob.

Gerry could grasp and release, push and pull the standard joystick knob with the palmar surface of his left hand (when his hand was pronated and elbow was resting on the tray surface). He often grasped the right edge of the tray to stabilize his right hand and assist in weight shifting his trunk forward slightly, over the tray. The joystick was placed at the level of the tray surface and was optimally controlled when directly in front of the left arm at the neutral resting position of the palm — 10" from body midline and parallel over the armrest. The top surface of the joystick box was at elbow height (tray surface height) and the joystick protruded 1 1/2". See Powered Mobility Joystick Survey form.

Stage 4: Powered Mobility Joystick Investigation

The orientation of the joystick described in the Survey was maintained for the Investigation stage. Gerry was assessed while driving a powered wheelchair with 3 different joysticks: a proportional joystick, a standard microswitch joystick, and a microswitch joystick that was gated.

The Team first assessed Gerry with a gated joystick which would continue to permit him control of the 4 directions and to stop, but not control of the speed of movement. During a month long trial, Gerry demonstrated his determination to drive with a joystick by becoming a proficient driver and exhibiting greater hand control and stability when he stabilized his elbow on the tray and moved only distal arm joints through smaller ranges. Subsequent to his recent surgery, Gerry's posture and seating had improved to the point that control of a standard microswitch joystick without the "gate" feature was easy. He was able to progress to and master the 360 degree directional control and movement grading required by a proportional joystick. In this instance, it was fortunate that the powered wheelchair took 3 months to arrive as Gerry used the waiting period to master joystick driving. Thus the proportional joystick was substituted for the microswitch joystick through a trade with the vendor upon the arrival of the wheelchair. No modifications to the joystick were required (lengthening or altering handle, damping etc.).

Within a month, Gerry was able to drive safely and effectively through wide hallways and doorways, and past moving people and obstacles. He was deemed to be a functional indoor driver and would require supervision and instruction for outdoor driving. See Powered Mobility Joystick Investigation form.

Figure 17: Driving with proportional joystick

Stage 5: Propose

In order to determine the potential impact of the features on the access systems to be proposed, each feature was examined by the client, facilitators and Team. Through careful examination of the inherent factors relevant to each feature the Team assigned descriptors (critical, important, desired, a consideration, no concern) which helped priorize the items. Through consensus, the group rated the features, gathered within each group, creating the following priority list:

- Affordability: no concern
- Attractiveness: consideration
- Circumstance adaptability: crucial
- Durability: crucial
- Environmental flexibility: desired
- Intersystem compatibility: consideration
- Manageability: crucial
- Mounting flexibility: no concern

- Portability: important for the VOCA, a consideration for the computer.

These features and Gerry's access system requirements for control of a stationary computer and VOCA as specified on the Keyboard Investigation form were reviewed. VOCAs with the appropriate characteristics were tried with Gerry and the VOCA which allowed him the most accurate access was selected. In addition, it was revealed that the VOCA could be used to control a stationary computer through the use of a keyboard emulating interface.

Gerry's current vocabulary and spelling skills when using traditional orthography through the VOCA provided sufficient fixed and potential vocabulary for the academic software he would use in the classroom. The current academic goals for Gerry are:

- To develop grammar concepts
- To write about familiar topics/people
- To attempt to spell words through identifying the initial consonants and word approximation/attack skills.

In order to avoid placing unnecessary cognitive demands on Gerry, the VOCA's current selection set was used for computer input as well as face-to-face communication and written work. It is anticipated that Gerry will use some form of transparent predictive linguistics program which will allow him to decrease the number of keystrokes and will expand his selection set for word processing and other academic work.

Figure 18: VOCA connected to computer

For powered mobility control, the standard proportional joystick which accompanied the specific wheelchair selected by the comprehensive assessment team was used.

Stage 6: Personalize

Contact person Currently, for the remaining school year, Gerry's school occupational therapist will be the contact person who will be responsible for ensuring that Gerry is instructed in functional competence with the power wheelchair (indoors and outdoors), and computer access through the VOCA. Once the initial set-up programming has been performed by the Access Team, the therapist will also be involved in setting up the workspace at home and in the instructional environments, routine programming, maintenance, and trouble-shooting.

Gerry's mother has agreed to be the contact person at home. Gerry's parents, with support by Gerry's older siblings, will undertake to set up the workspace at home, maintain, and trouble-shoot.

The new school and teacher will be approached regarding establishing a contact person once placement has been determined.

The Access Team's instructor will be the "expert" responsible for training all facilitators and addressing less routine trouble-shooting and programming. The funding source will pay for maintenance; warranties will be honoured by the vendor.

Customize

Selection set The selection set would remain unchanged from the specifications in the Keyboard Investigation form. However, computer application functions have been added under a "magic key" approach and are listed on the selection set display on the VOCA.

Input device The input device was arranged as specified in the Investigation stage.

Application information

For the computer, a voice synthesizer was added to allow Gerry to experiment with sounding out words for spelling, or reviewing sentences/phrases for learning grammar and syntax. He turns down the voice output on the VOCA during computer use to cut down on the echo effect.

Modification of application information is not applicable for power wheelchair access.

Physical integration

The Access Team met with representatives from the Seating and Powered Mobility Services to consider the optimal arrangement of joystick and VOCA mounting on Gerry's tray. Gerry was seated in the type of wheelchair he would be receiving, in his insert with a tray and his VOCA on top. The tray was lowered to allow the surface of the devices to be as close to their final height as possible. Various component locations and orientations were tried until a functional arrangement was determined. A sketch was prepared for the technician in charge of mounting.

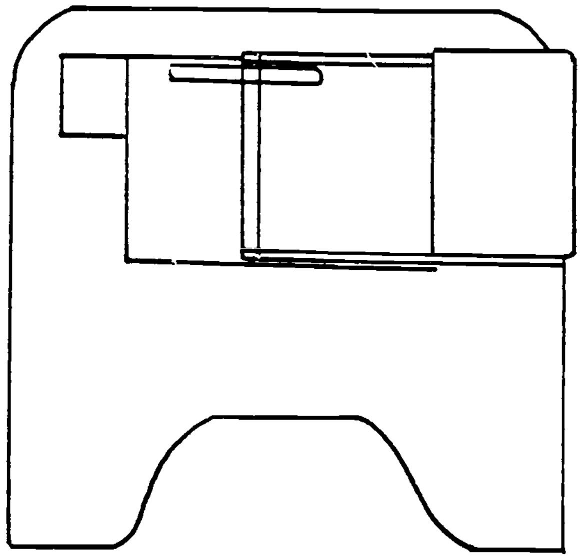

Figure 19: Sketch for mounting components on tray

Since the VOCA would be taking up much of Gerry's ideal work area on his tray, and must also be portable, modifications to his graphic display were required. A slider was designed to permit mounting a small menu folder directly onto the VOCA. Gerry could push this to one side when using the VOCA. His graphic display was modified to fit into this menu folder so as to be available at all times.

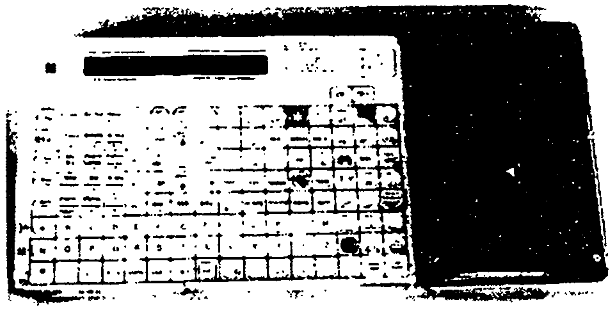

Figure 20: Slider on VOCA with graphic display closed

In order to ensure Gerry's potential for independence with the computer, it was necessary to change the position of the power bar and use a 3.5" floppy disk drive. The parents were advised to place these devices on a shelf which would extend over the left side of Gerry's tray. Securing the devices to the shelf at the proper orientation provides Gerry with the stability to operate them. The monitor should be at eye level, directly in front of Gerry.

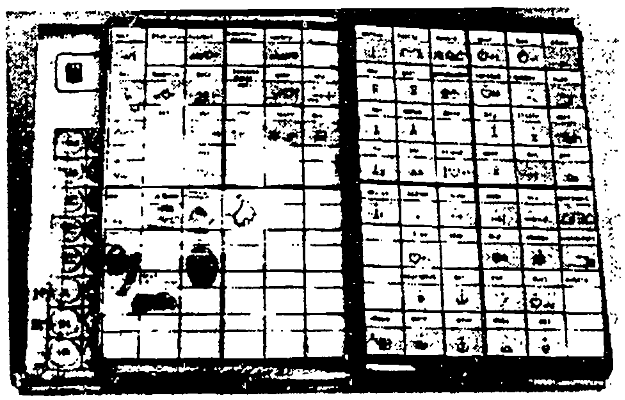

Figure 21: Slider on VOCA with graphic display opened

Evaluate Gerry became operationally competent with the powered wheelchair and VOCA within the initial trial period. Over a week, he quickly increased in functional competence.

Modifications Once experimentation with a variety of software applications began, there was the need to add more computer functions into the selection set.

Stage 7: Train

Wheelchair Due to Gerry's previous experience with driving using the touchplates, he was quickly able to transfer his expertise with mobility control to the joystick. In addition, his recent surgery allowed him to be easily seated in a proper position which gave him greater sitting stability.

From the more stable base of support, Gerry was able to perform better fine motor functions bilaterally, and to become functionally competent in driving. Therefore formal training was not required. The classroom teacher assumed responsibility for instructing Gerry in functional use of the wheelchair when outdoors.

Computer Due to Gerry's previous experience with access to the computer through the membrane keyboard, and expertise with the VOCA, extensive training was not required. Gerry became operationally and functionally competent within two weeks. He continues to be able to guide facilitators through the typical set-up procedure.

Gerry's mother was invited in for two facilitator training sessions regarding the use of the equipment, maintenance, basic trouble-shooting, programming, and how to set the system up at home. Gerry's parents were instructed in the care and management of the powered mobility system, and how to remove the VOCA from the tray. Information regarding the vendors and service departments was provided along with warranties and manuals.

Stage 8: implement

The computer system was fully assembled with the monitor, 3.5" and 5 1/4" disk drives, printer, speech synthesizer, keyboarding emulator, a selection of software (e.g., academic and communication/word processing), the cable to the VOCA, power bar, and necessary computer cards. This was checked to ensure that it would work properly and the keyboard emulating interface was prepared so that Gerry could automatically start from the set-up menu.

Gerry's parents took the computer system and VOCA home and set it up according to the instructions given in handout form. Telephone support was available. One week later, an Access Team representative made a home visit to ensure that the system was working properly, that Gerry was able to manage as independently as possible (i.e., do everything but plug and unplug the VOCA cable to the computer) and to answer any questions about Gerry's computer experiences. There were no concerns about environmental compatibility or learning, and the discussion focused on the software applications and achieving Gerry's academic goals at home. The parents were reminded of support services (i.e., Access Team instructor) available by phone for trouble-shooting, and were informed of whom to contact at the vendor and service dealers regarding the warranty provisions and method of payment.

The Access Team will be following up in September, with the new school staff.

Stage 9: Monitor

Roles The mother will contact the appropriate resources for assistance, and carry out maintenance and trouble-shooting as required.

The therapist will instruct Gerry in ways to increase his functional competence in accessing the different technology. She will record progress, change, and difficulties, and report these to the Team.

As soon as possible, she will inform the Access Team of Gerry's new school placement and teaching staff, then establish the initial contact with the school regarding Gerry's computer needs for academic work. She will forward Gerry's school set-ups, information regarding his academic software, and the environmental compatibility demands for the wheelchair to the new location.

The Access Team will train the new facilitators at the school (if required), and support them while they set up Gerry's VOCA, computer system, powered wheelchair, and instructional formats.

The Team will reassess Gerry annually to determine if his access systems should be altered, and will be available for consultation.

Client's name: Gerry

Clinician's name: D. J.

Date: Nov '87

Features of Total Access System

Feature	Client information & consideration		Concern: Yes	Concern: No	Details relating to the feature.
Affordability	general info	- age related restrictions		✓	What price range is acceptable? must fit within the ADP prescription mandate
	funding	- limits on assessment, training, follow-up, prescription		✓	
		- deadlines, timelines		✓	What funding timelines exist? none: as long as wheelchair is ordered after April 1/88
	facilitator support	- people/time available for training			
Attractiveness	sensory/perceptual	- visual preference - auditory preference - tactile preference/safety		✓	List any client and facilitator concerns regarding attractiveness of access system(s). shouldn't look too technical or overpowering
	facilitator support	- preference			
Circumstance adaptability	general info	- academic learning - anticipated physical maturation	✓		How adaptable does access system need to be to meet the client's changing needs? client growing and maturing. The system must be able to meet increasing academic demands and transition to traditional orthography.
	medical info	- prognosis/urgency		✓	
	communication	- more types of selection sets - changing selection sets	✓		
System durability	general info	- age/maturity level	✓		How durable should it be? must be able to withstand the perils of adventure with a young and active boy i.e., protected from the elements, able to withstand jostling over rough terrain, able to withstand poorly co-ordinated and occasionally forceful movements and control acts.
	routines	- stresses placed, transfers, - transportation/storage - environment problems (indoors/outdoors)			
	motor skills	- control acts (roughness) - involuntary movements	✓		
	learning / behaviour	- responsibility - judgement	✓		
	mobility	- mounting on to wheelchair, walker, etc.	✓		

Client's name: Gerry

Clinician's name: D.J.

Date:

Features of Total Access System

Feature	Client information & consideration		Concern Yes	Concern No	Details relating to the feature.
Environmental flexibility	routines	- environment, programming, - space and time limits	✓		How does access system need to accommodate to each environment? home - can't fit w/c in house, computer will have to be in livingroom. school - leisure - no difficulties
Intersystem compatability	target systems	- past - present	✓		What target systems should access system(s) be compatible with? computer and VOCA - access systems should be as similar as possible. would be ideal if ECU could be accessed through w/c or VOCA.
Manageability	medical info	- urgency of need - prognosis		✓	How managable does it need to be for the client? The more that Gerry can do for himself - the better. He is keen to be independent and to control technical devices.
	communication	- representation system - setup / programming - instructional approach	✓ (home)		
	learning/ behaviour	- instructional approach - starting point for training		✓	
	facilitator	- # of facilitators - time available - experience and motivation - instructional approach	✓ (home)		How manageable does it need to be for the facilitator / contact person? English is the second language at home. Instructions and procedures should be kept simple, clear and concise.
Mounting flexibilty	funding	- money available		✓	How flexible should mounting be? Gerry sits in a variety of chairs and can move independently on the floor, thus, the computer and VOCA should be accessible when he is out of the w/c.
	positioning	- number type of positions	✓		
	routines	- environment, programming - space and time limits		✓	
	sensory/perceptual	- tactile		✓	
Portability	positioning	- number type of positions	✓		How portable does the access system need to be? The VOCA can be carried on the tray or wheelchair but must be removable and repositionable (floor or table).
	routines	- environment, programming - space and time limits	✓		

Assessment Considerations

Client's name: Gerry

Clinician's name: D.J

Date: Nov '87

Considerations	Concern Yes	Concern No	Requirements for Assessment: Equipment / Expertise	Approach	Environment
Medical Information/ Status					
- urgency of need		✓			
- medical condition prognosis		✓			
Funding					
• limits on - assessment		✓			
- training and follow-up		✓			
- prescription		✓			
- deadlines		✓			
Positioning					
- alternative positions (bed, standing)	✓				W/C, variety of chairs, on floor
- transfers (pivot, 2-man lift)	✓		equipment removable for assisted pivot transfers		
Routines					
- physical space limits (crowded room)	✓		home computer - to go in livingroom		
- timing limitations (sufficient for daily set-up)		✓			
- environmental obstacles/concerns (lighting levels, noise, changes/moving)	*✓				once school placement determined - Team to investigate
- self-care independence	✓			Train Gerry to be as independent as possible	
Motor Skills					
- control acts (points with finger, lateral neck flexion to left and right)	✓		stabilized right hand on tray edge	decrease overflow to shoulders and elbows	
- contact sites		✓	tip of left index finger or thumb		
- involuntary movements (reflexes, tremors)	✓			overflow/athetosis	

Client's name: Gerry

Clinician's name: D.J

Date: Nov '87

Assessment Considerations

Considerations	Concern: Yes	Concern: No	Requirements for assessment: Equipment / Expertise	Approach	Environment
Sensory/Perceptual Abilities					
· Vision		✓			
· Hearing		✓			
· Tactile		✓			
Communications					
· representation system(s) to be used, (photos, traditional orthography, symbols)	✓		moving to traditional orthography - from Bliss	Dual representation (T.O. and BLISS) may benefit from predictive linguistics or word completion (future)	
· other (speech, sounds for voice input)		✓			
Learning and Behaviour					
· maturation / learning potential		✓	learns quickly	keep clear, simple, concise (meaningful)	
· attention, choice making, cause-effect, motivation, directionality, judgement		✓			
Facilitator Support					
· # people expected at assessment		✓	4 - teacher, mom, S.L.P., O.T.		larger clinic room with observation room
· support people available	* ✓		experienced staff at old school	use A.V. recording for information transfer (new school)	* must determine once Gerry in new school
· facilitator skills & experience	✓		parents and siblings - slightly aprehensive		
Accessing Needs and Experience					
· access skills required for desired target systems (critical timing, sustained endurance)		✓	Computer, VOCA, w/c } Gerry has had previous experience training and support with each of these!		
· other					

Direct Selection Survey

Client's name: Gerry

Clinician's name: D.J.

Date: Dec. '87

Accuracy = A
H = no errors
M = some errors
L = frequent errors

Ease = E
H = no exertion
M = some exertion
L = overexertion

Quality = Q
H = smooth movement
M = some involuntary movement
L = erratic movement

Describe movement pattern	Stabilizer	Control extender	Contact site	Optimum orientation a - distance to body b - angle c - body midline d - table height	Working area	Minimum target size	Maximum # of targets	A	E	Q	Comments
Right upper limb fixes wrist in flexion fisted hand, movement is initiated from his shoulder	uses left hand for support sitting in insert	/	unable to isolate fingers - uses fist	a- 3"-5" b- flat or 10° incline c- 3" towards right d- elbow height	14" × 18"	1" squares with large spacing	about 64	M	M	M	
Left upper limb wrist flexed, hand more open, movement initiated from shoulder and elbow	insert uses right hand for stability (less dependent)	/	uses left index finger tip and/or thumb tip	a- 3"-5" b- flat c- 3" to left d- elbow height	24" × 26"	½" squares with small spaces (¼-½")	more than 128	H	H	M	
Head and neck											
Mouth and Face											
Other (e.g., lower limbs, voice, eye-gaze)											

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Keyboard Direct Selection Investigation

Client's name: Gerry

Clinician's name: D.J.

Date: Dec. 87

Accuracy	Ease	Quality
H = no errors	H = no exertion	H = smooth movement
M = some errors	M = some exertion	M = some involuntary movement
L = frequent errors	L = overexertion	L = erratic movement

Summary of client control (If different from Survey)

Control act: left index finger tip contacting target point

Stabilizer: occasionally holds keyboard edge with left hand and activates keys near the periphery with thumb. Right hand holds tray edge.

Control extender:

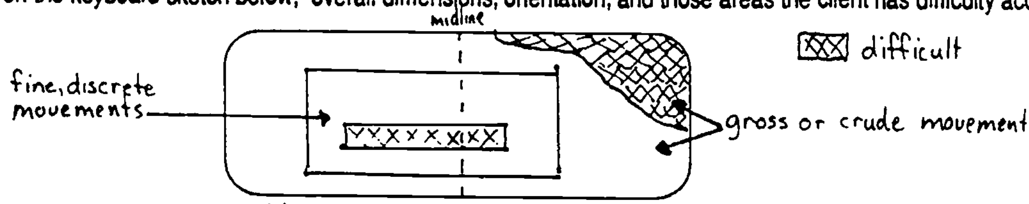
Contact site: finger tip

Status of client control

Accuracy	Ease	Quality	Comments
L M H (M circled)	L M H (H circled)	L M H (H circled)	as long as Gerry is well supported posturally

Keyboard characteristics required

Mark on the keyboard sketch below, overall dimensions, orientation, and those areas the client has difficulty accessing.



Size of targets: $\frac{1}{4}$" to $\frac{1}{2}$" squares

Spacing of targets: $\frac{1}{8}$" to $\frac{1}{4}$"

Number of targets accessible: 128+

Types of feedback—visual, auditory, tactile, kinesthetic, other: auditory click, kinesthetic desired

Minimization techniques—keyguard, defeat autorepeat, key delay, filter, other: keyguard (square hole)

Amplification techniques: —

Selection set characteristics required

(Size, #, and spacing corresponds to keyboard characteristics unless levels are used; if different, specify below)

Size of items: same as targets

Spacing of items: same as targets

Number of items: 150+

Representation system used—pictures, symbols, traditional orthography, other: Traditional Orthography, Bliss, drawings

Modality—visual, tactile, auditory, other: visual

Highlighting of items—colour contrast, emphasize lines, other: familiar colour coded layout

Organization of apparent items—ABC, QWERTY, frequency of use, categories, other: ABC; categories (familiar)

Organization of hidden items—levels, pages, other: levels under a "magic key" - cued on VOCA

Encoding techniques—abbreviation expansion, predictive linguistics, semantic compaction, other: abbreviation - expansion

Location of selection set—on physical keyboard, on monitor screen, other: on keyboard

Powered Mobility Joystick Survey

Client's name: Gerry

Clinician's name: D. J.

Date: Jan-Feb '88

Accuracy = A
H = no errors
M = some errors
L = frequent errors

Ease = E
H = no exertion
M = some exertion
L = overexertion

Quality = Q
H = smooth movement
M = some involuntary movement
L = erratic movement

+ = able
− + = difficulty
− = unable

Describe movement pattern	Stabilizer	Control extender	Contact site	Optimum orientation a - distance to body b - angle c - body midline d - table height from top of thigh	Grasp	Release	Push FWD	Pull BKD	Push LT	Push RT	A	E	Q	Comments
Right upper limb couldn't hold or control joystick														
Left upper limb palmar grasp of joystick. Hand in pronation, elbow flexed, resting on tray	arm resting on tray surface or armrest	/	palmar surface of left hand (grasping)	a- over w/c armrest 10" forward of body b- flat surface c- 8" from tray midline d- elbow height	+	+	+	+	+	+	H	H	H	very keen to use a joystick (not the 5 switches)
Head and neck														
Mouth and Face														
Other (e.g., lower limbs, voice, eye-gaze)														

Powered Mobility Joystick Investigation

Client's name: Gerry

Clinician's name: D.J

Date: Jan 88 - Feb 88

Accuracy	Ease	Quality
H = no errors	H = no exertion	H = smooth movement
M = some errors	M = some exertion	M = some involuntary movement
L = frequent errors	L = overexertion	L = erratic movement

Status of client control

Accuracy	Ease	Quality	Comments
L M H	L M H	L M H	very motivated to practice

Summary of client control (if different from Survey)

Control act: palmar grasp with left hand

Stabilizer used: left arm rests on armrest or tray, right hand grasps tray rim (if present)

Control extender: —

Contact site: palm

Optimum orientation: level with tray/armrest, 10" from body, 6" from left tray edge, parallel with armrest

Joystick characteristics required

Type of joystick used: proportional, microswitch, other: proportional

Minimization techniques:

- gated joystick? not required
- lengthen joystick? no
- damping? no

Driving Ability

Does the client understand how each joystick activation affects the wheelchair movement (i.e., cause/effect concept)?

yes ✓ no __ Comments

Rate and comment on the client's ability in the following tasks:

Ratings: + = able +– = difficult – = unable

On command

Stop	Fwd	Rt	Lt	Rev
+	+	+	+	+

Able to scan path? yes

Comments: functional indoor driver

Without command

Stop	Fwd	Rt	Lt	Rev
+	+	+	+	+

Able to scan path? yes

Comments: very careful and considerate

Appendix E Resources for Funding Options*

Anderson, S., Steven, J., & Trachtman, L. (1990). *A guide to funding resources for assistive technology in South Carolina, January 1990.* West Columbia, SC: Center for Rehabilitation Technology Services.

Enders, A. (1983). Funding: The bottom line. In *Proceedings, 6th Annual Conference on Rehabilitation Engineering*. Washington, DC: RESNA.

Funding of assistive technology for individuals with disabilities. (1990). Six audiotapes from Technology Assistance Project workshop. Washington, DC: RESNA and United Cerebral Palsy Association.

Mendelsohn, S. (1987). *Financing adaptive technology: A guide to sources and strategies for blind and visually impaired users.* New York, NY: Smiling Interface.

Reimbursing adaptive technology. (1989, winter). *NARIC Quarterly.* Silver Spring, MD: National Rehabilitation Information Center for Children and Youth with Handicaps.

Reeb, K. (1987). *Revolving loan funds: Expanding equipment credit financing opportunities for persons with disabilities.* Washington, DC: Electronics Industries Foundation.

Rice, R. (1989). Federal legislation and assistive technology. In *NICHCY News Digest, No. 13.* Washington, DC: National Information Center for Children and Youth with Handicaps.

Ripley, S. (1989). Starting the funding process. In *NICHCY News Digest, No. 13.* Washington, DC: National Information Center for Children and Youth with Handicaps.

See Appendix A for additional funding references.

* This listing was compiled by the American Speech-Language-Hearing Association (ASHA). It does not attempt to be all-inclusive nor does it imply ASHA endorsement.

Appendix F Characteristics of Selected Wheelchairs

The following is a small sample of the wheelchair descriptions included in *The Wheelchair*, a supplement to the May 1991 issue of *Homecare*. The complete chart, which can be obtained from Homecare, PO Box 16448, N. Hollywood, CA 91615-6448, describes and illustrates standard manual wheelchairs, lightweight performance manual wheelchairs, lightweight standard manual wheelchairs, lightweight high-performance manual wheelchairs, and power wheelchairs, as well as strollers and scooters. The chart is updated annually.

Company Name / Model Name / Reader Service No.	Rider Design	Frame Design	Custom Built Only	Model On Market	Weight	FRAME: Material[1]	FRAME: No. of Colors	FRAME: Upcharge For Some Colors	FRAME: Some Colors Add To Delivery Time	WHEELS: Front Caster Size	WHEELS: Rear Wheel Size	WHEELS: Brake Type[2]	TIRES: Standard[3]	TIRES: Extra Charge[4]	AXLE ADJ.: Vertical Movement	AXLE ADJ.: Horizontal Movement	Camber Degree	Adjustable Front Caster Block
Redman Wheelchairs Cherokee 102W RS #446	Adult	Folding	No	6 yrs	29 lbs	C	1	$150	Yes	8"	24"	A.B	A D					No
Redman Wheelchairs Cheyenne 107LW RS #447	Adult Pediatric	Folding	No	6 yrs	29 lbs	C	1	$150	Yes	8"	24"	A.B	A. D					No
Redman Wheelchairs Mohave RS #448	Adult	Folding	No	6 yrs	37 lbs	C	1	$150	Yes	8"	24"	A.B	A. D					No
Theradyne Corp T-Bird 1 RS #387	Adult Pediatric	Folding	No	2 yrs., 6 mos	21 lbs 8 ozs	F	4	No	No	8"	24"	B.G	D	A	0°	2°	2°	No
Theradyne T-Bird RS #449	Adult Pediatric	Folding	No	3 yrs 8 mos	22 lbs 8 ozs	F	4	No	No	8"	24"	A.B. D.G	D	A			1°	No
Tuffcare 60 RS #450	Adult	Folding	No	4 yrs	32 lbs 8ozs	C	1			8"	24"	B	E	A				
Tuffcare 660 RS #451	Adult	Folding	No	4 yrs	30 lbs	C	1			8"	24"	B	E	A				
Tuffcare 770 RS #452	Adult	Folding	No	4 yrs	30 lbs 8ozs	C	2	No	No	8"	24"	B	E	A				

FOOTNOTES:

[1]Frame Material
A=Stainless Steel
B=Chrome
C=Chromoly
D=Aluminum
E=Airplane Aluminum
F=Steel Tubing
G=Titanium
H=Steel Alloy
I=Graphite

[2]Brake Type
A=Toggle
B=Push Lock
C=Pull Lock
D=Extensions
E=Low-Mount
F=Mid-Mount
G=High-Mount
H=Scissor

[3]Standard Tires
A=Pneumatic
B=Pneumatic Radial
C=Sew-Ups
D=Polyurethane
E=Solid
F=Nylon
G=Semi-Pneumatic
I=Semi-Pneumatic Inserts

[4]Optional Tires, Extra Charge
A=Pneumatic
B=Pneumatic Radial
C=Sew-Ups
D=Polyurethane
E=Solid
F=Nylon
G=Semi-Pneumatic
I=Semi-Pneumatic Inserts
K-Flat Frees

CHAIR SIZE (Height, Width, Length)		STANDARD SEAT											
Open	Folded	Width	Height	Depth	Back Height	Seat Tilt	Back Angle	Front Frame, Footrest Features	Armrest Features	Other Features	Delivery Time From Date of Dealer Order	Consumer Price	Warranty
36"H 24-26"W 36-40"L	13"W	16-18"	19 75"	16"	16 5"	3-5°	3°	A,E G,J	C,G	A,B, D,J K	30 days		Limited
36"H 24-26"W 36-40"L	12"W	16-18"	19 75"	1G"	16 5"	3-5°	3°	A,E, G,J	D,E, G,H	A,B, D,J, K	30 days		Limited
40"H 24-26"W 36-40"L	12"W	16-18"	22"	17"	16 5"	3-5°	3°	A,E, G,J	D,E, G,H	A,B, D,J, K	30 days		Limited
36" H 25" W 41" L	11"W	14" 16", 18"	17 1/8", 20"	16"	16.5"	3 5°	10°	A,E, G,H, J	B-H	B,C, E F, L	10 days	$835-$1,070	Lifetime frame x-brace
36"H 26"W 39"L	11"W	14", 16", 18"	20"	16"	16 5"	3.5°	100°	A,G, J	C-E, G,H	B	10 days	$865-$985	Lifetime Frame X-Brace
36"H 24 5"W 40 5"L	10"W	16", 18"	20"	16"	18"			A,G	D,E, G,H	B,E, F,K	4 days	$267-$319	Limited Parts X-Brace
36"H 24 5"W 40 5"L	10"W	16", 18"	20"	16"	18"			A,G	C,G	B,E F,K	4 days	$227-$277	Limited Parts X-Brace
36"H 24 5"W 40.5"L	10"W	16", 18"	20"	16"	18"			A,G	D,E, G,H	B,E, F,K	4 days	$284 $337	Limited Parts Frame X-Brace

Front Frame, Footrest Features
A=Swing-Away Footrest
B=Swing-Under Chair Footrest
C=Fixed Footrest
D=Euro Ped Footrest
E=Flip-Up Footrest
F=Reverse Mount Footrest
G=Elevating Legrest
H=Calf Strap
I=Foot Saver Plate
J=Footrest w/Heel Loops
K=Impact Guards, Nylon Leg Strap
L=Custom Minimum Footboard Extension

Armrest Features
A=Flip Up
B=Swing Out
C=Full Length
D=Height Adjustable
E=Desk Length
F=Sport Style
G=Arm Pad
H=Removable

Other Features
A=Push Handles
B=Anti-Tippers
C=Quick Release Hubs
D=Quick Release Castors
E=Quick Release Axles
F=Amputee Adaptor
G=Castor Locks
H=Hillholder
I=Speed Control
J=Forward Folding Back Rest
K=Spokeless Wheels
L=Spoke Wheels
M=Stroller Handles